Joint Environmental Data Integration System: JEDI System

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Supported by JST

JST Crest Project

Novel technologies to evaluate multi-scale variations of pelagic marine communities and biodiversity under the influence of the Kuroshio and internal waves in coastal habitats

Principal Investigator Hidekatsu Yamazaki

Goal:

1) To develop a scheme to evaluate the dynamics of biodiversity of phytoplankton/zooplankton in Kuroshio-affected habitats.

2) To develop a new planktonic ecosystem model using a closure approach

Specific Objectives:

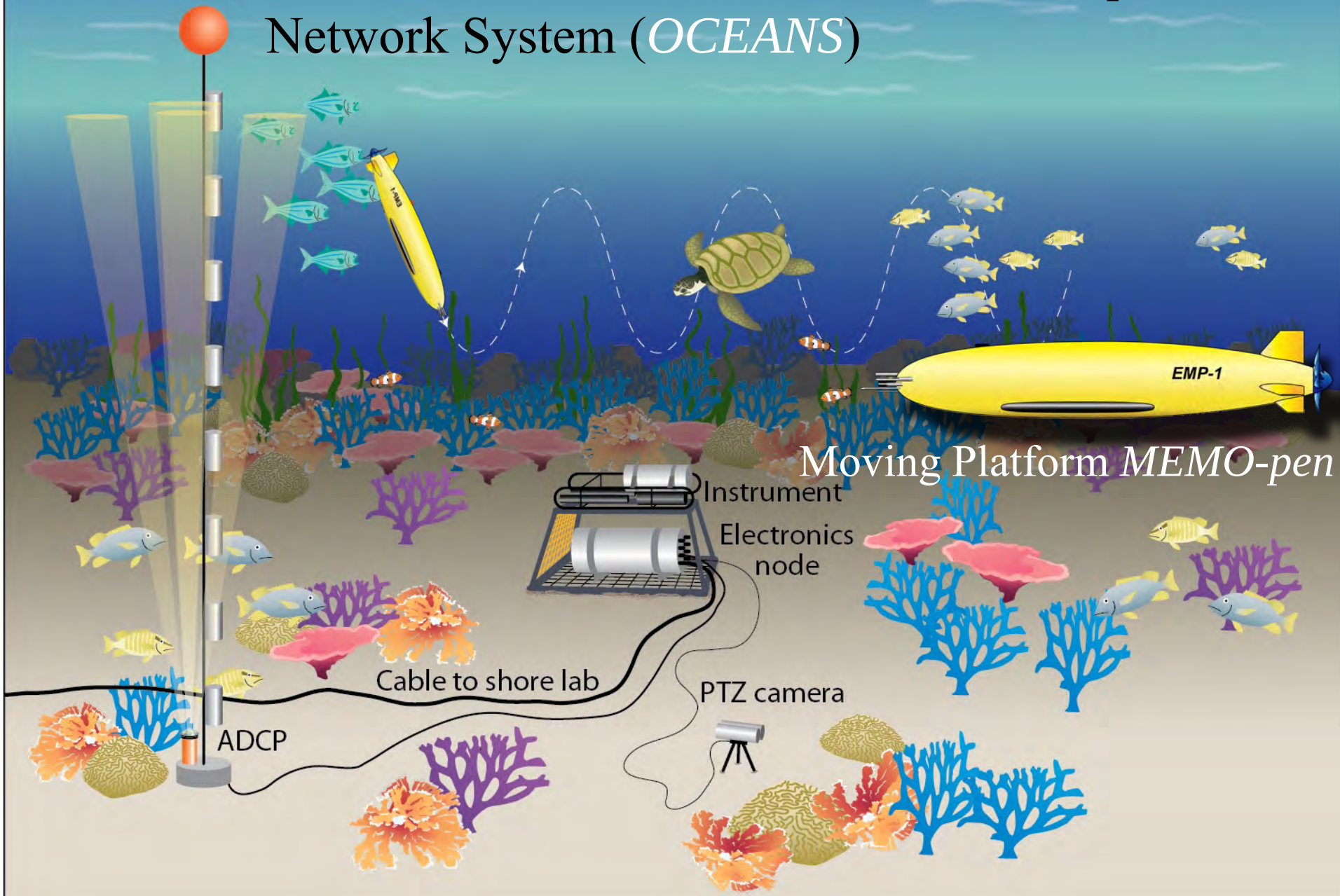
To characterize biodiversity dynamics in Kuroshio-affected habitats using a novel approach that combines numerical models with field observations obtained with advanced sensing technologies.

Joint Environmental Data Integration System: JEDI System

JEDI System HOMEPAGE http://www2.kaiyodai.ac.jp/~hide/JEDI/index.html

Observations

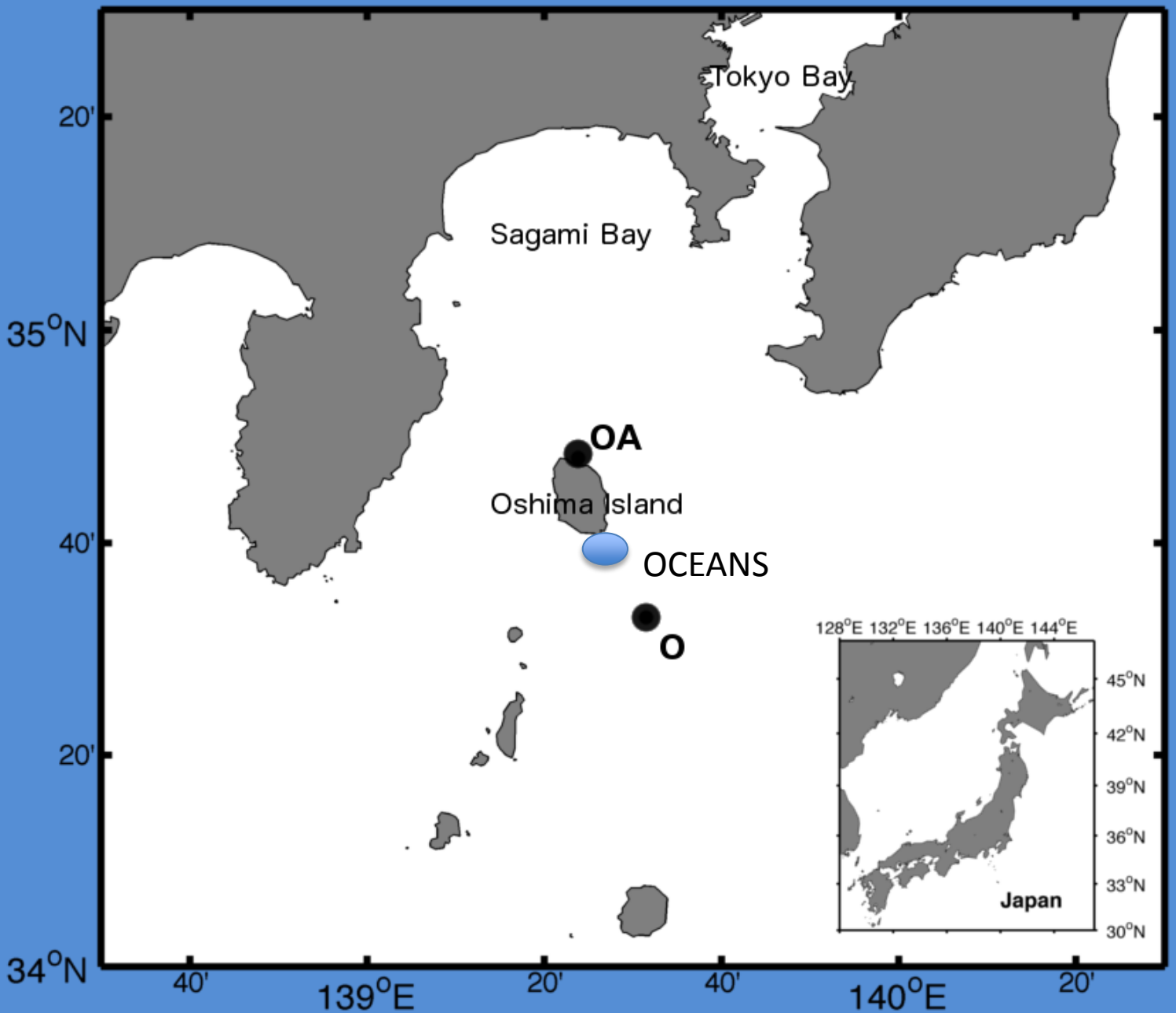
Oshima Coastal Environmental data Acquisition Network System (*OCEANS*)

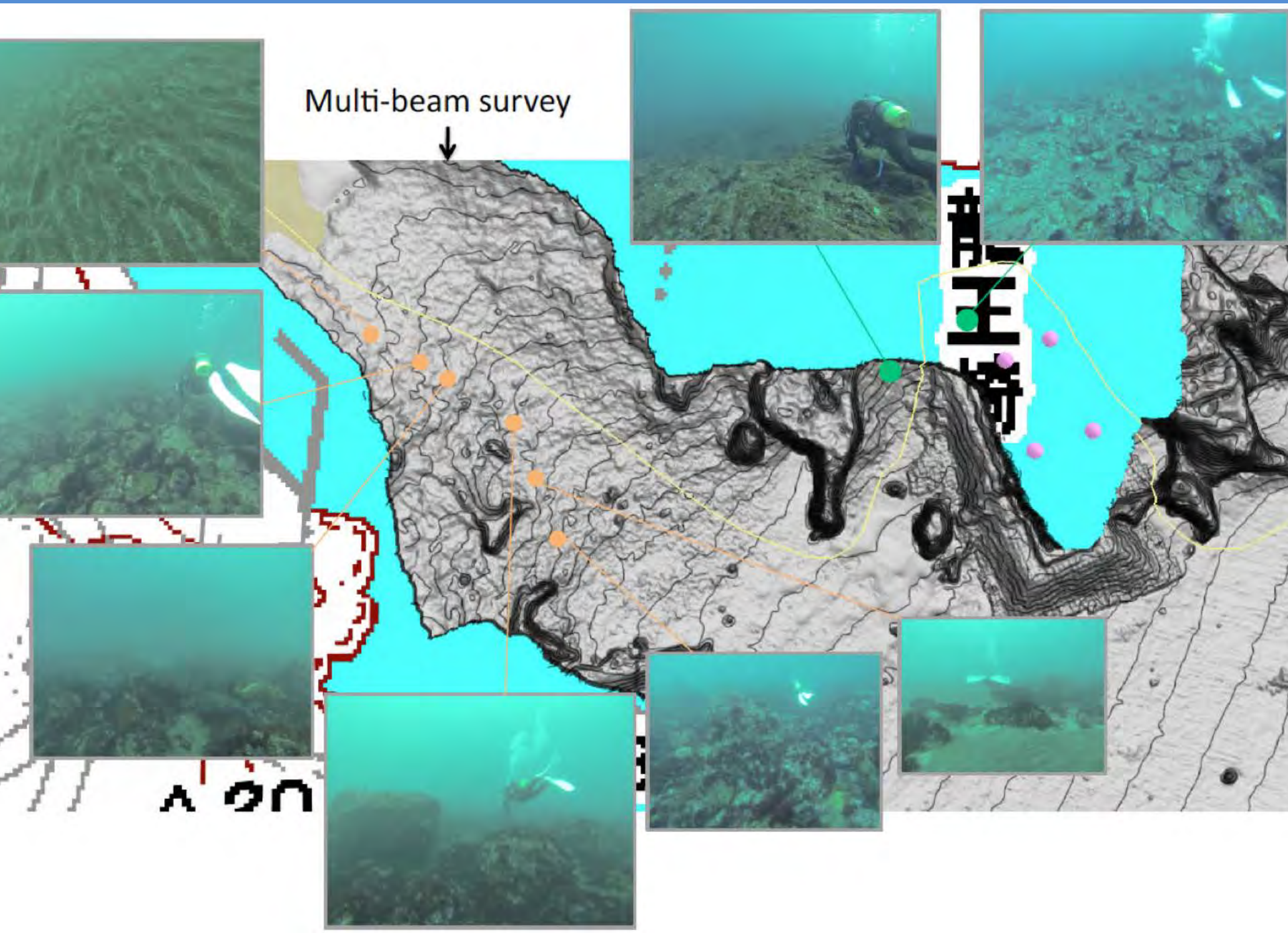


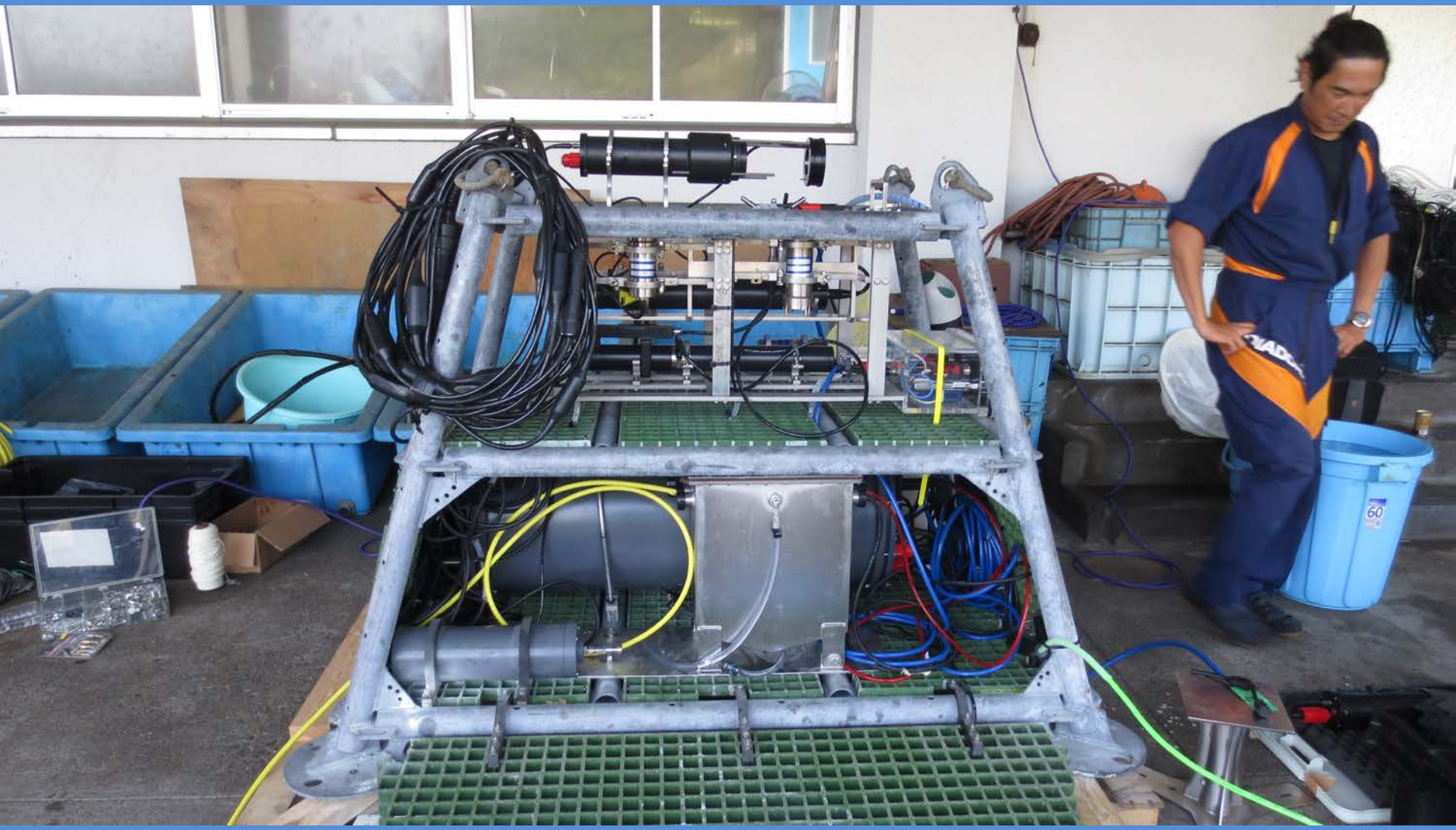
Sensor	Object	Sample rate
Physical		
CT sensor	Temperature, Salinity	1 Hz
T-string	Temperature	1 Hz
ADCP	Current	60 sec
ADV	Turbulence	8 Hz
PAR sensor	PAR	1 Hz
Pressure sensor	Pressure, Wave height	1 Hz
Biological		
CPICS	Plankton image	4 Hz
Chlorophyll/Turbidity sensor	Chlorophyll, Turbidity	1 Hz
Hydrophone	Mammal	Stream
Chemical		
SUNA	Nitrate	5 min
DO sensor	DO	0.2 Hz


Woods Hole Oceanographic Insti
PORT

The location of OCEANS




Multi-beam survey

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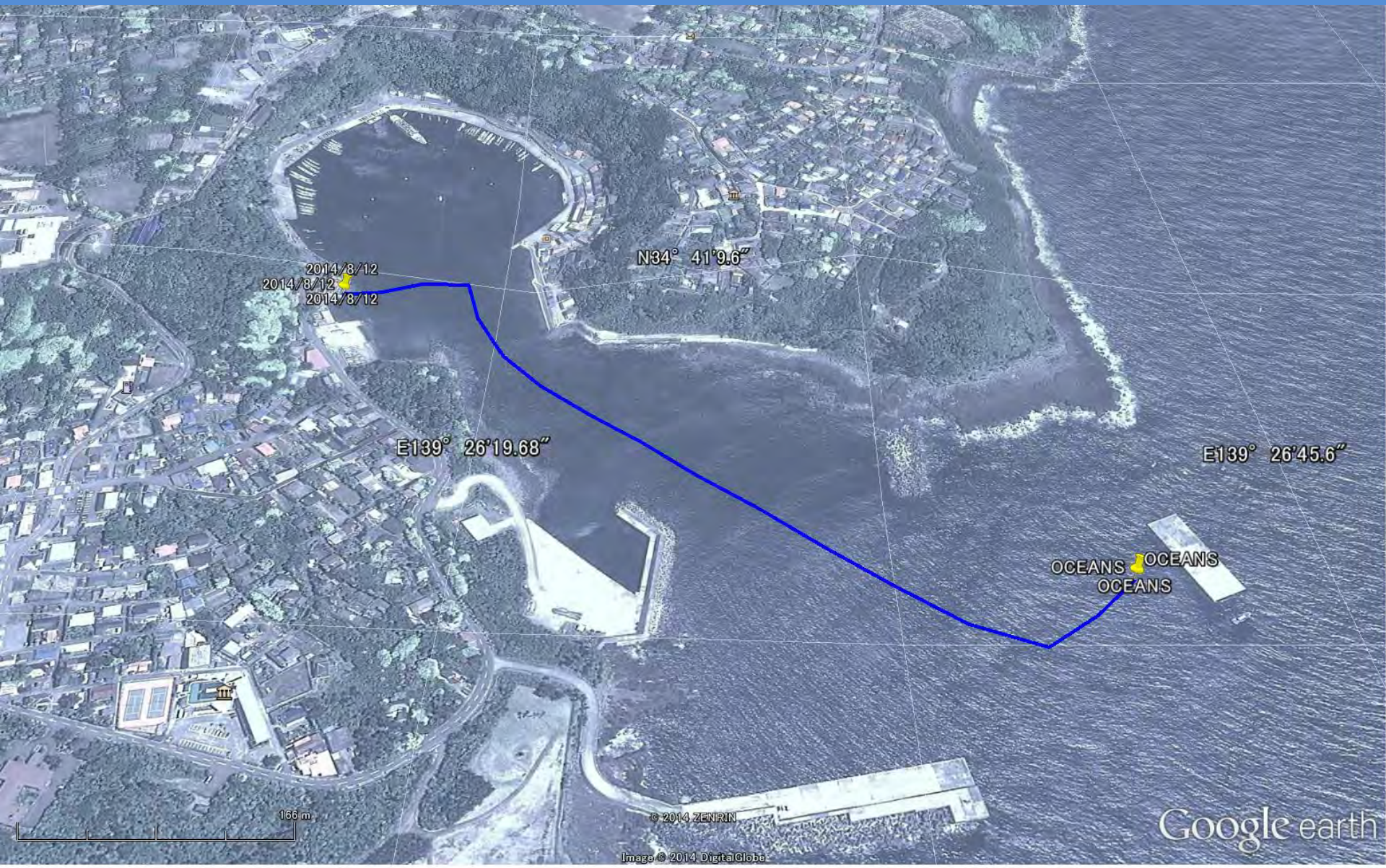
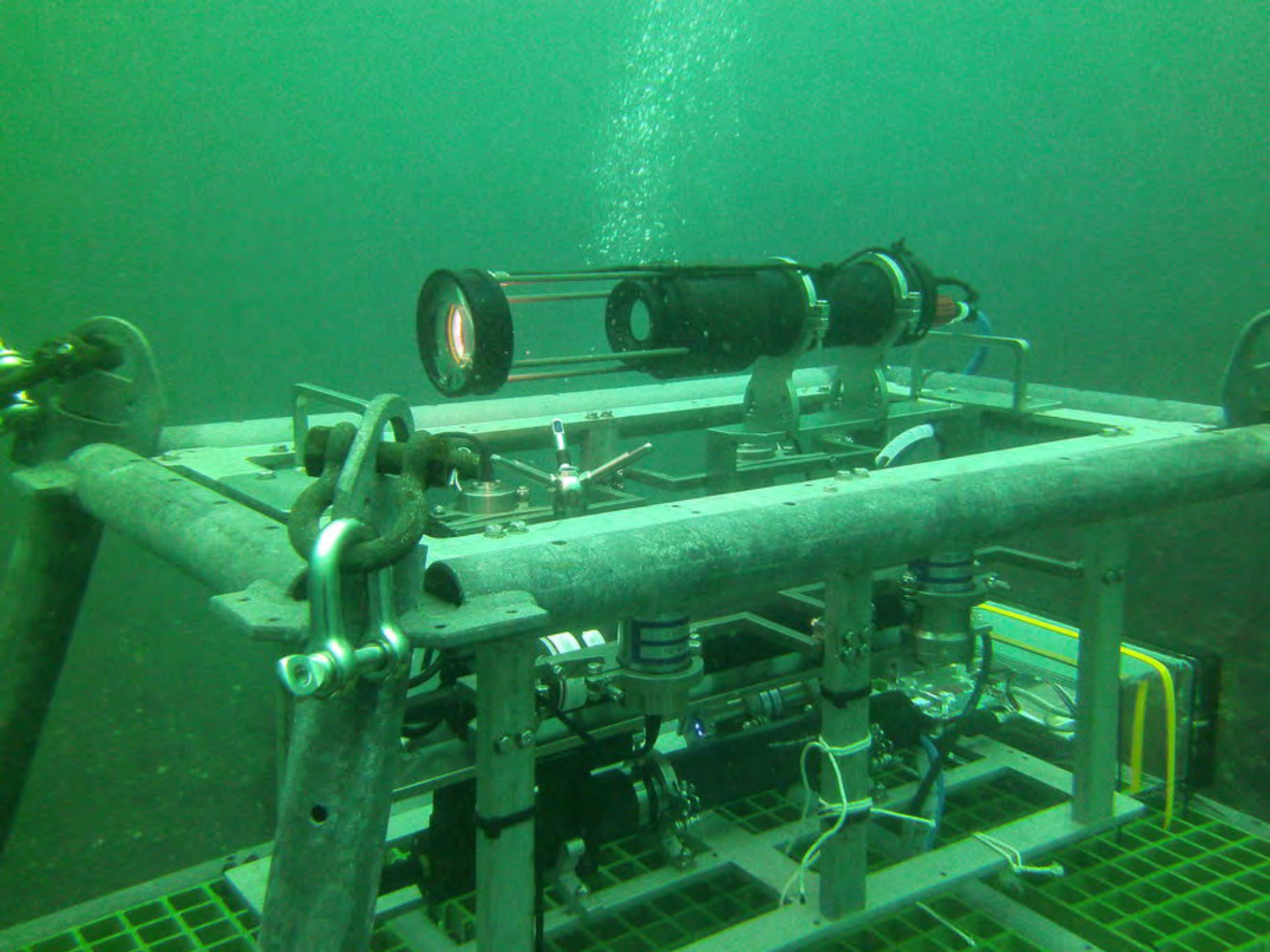
第八潮丸
波浮港


TK2-187


UNIC
TK2-1876

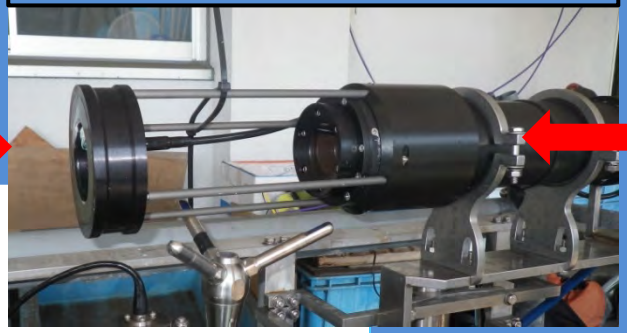

第八潮丸

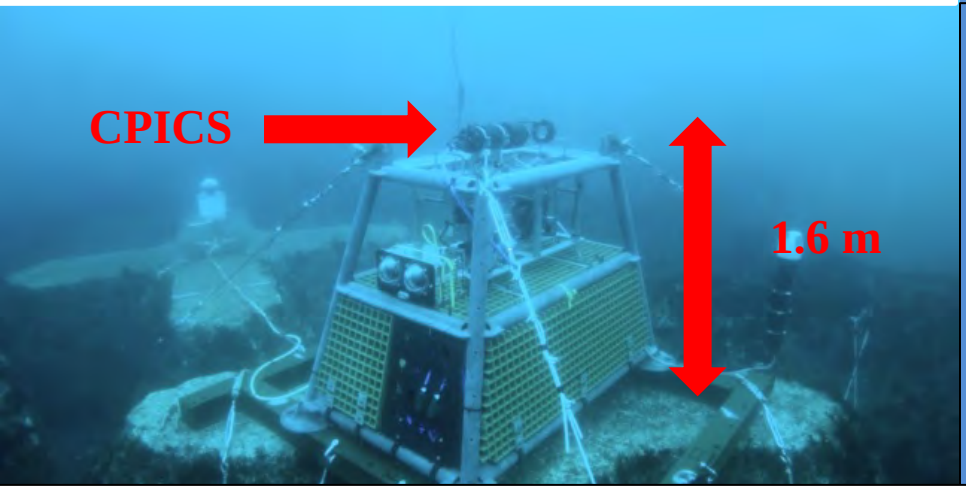

2014/8/12
2014/8/12
2014/8/12
N34° 41'9.6"
E139° 26'19.68"
E139° 26'45.6"
OCEANS
OCEANS
OCEANS
166 m
© 2014 ZENRIN
Image © 2014 DigitalGlobe
Google earth



Method | **Get image**

CPICS





Resolution：
2,750 x 2,300 pixels
Field of view：
11.0 x 15.0 x 2.0 mm
Frame rate：
6 frames per second (Image volume: 7.12 L h^{-1})
Particle size:
Larger than ca. 50 μm

CPICS take particle images living or non-living and save it as ROI (Region Of Interest) image automatically.

3 in-focus copepods taken with CPICS imaging system. (Continuous Plankton Imaging and Classification System)
FOV: 11 x 12mm
WD: 15 cm
Resolution: 2 µm

Three copepods with yellow Region of Interest (ROI) pixels extracted in real-time by FPGA (frame programmable gate array)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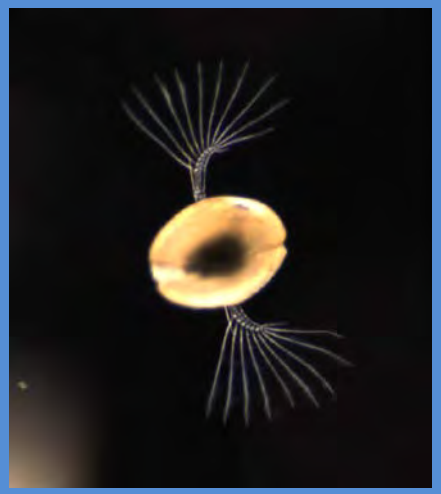
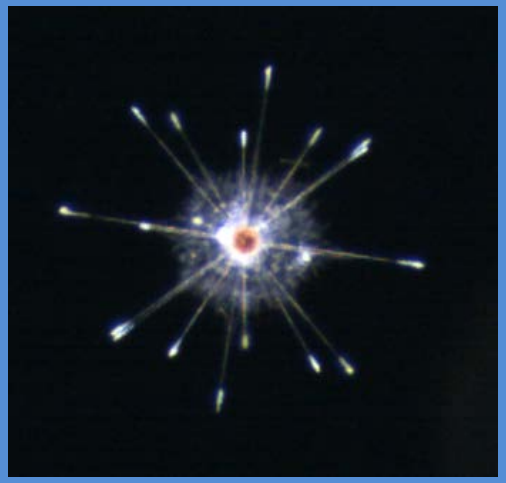
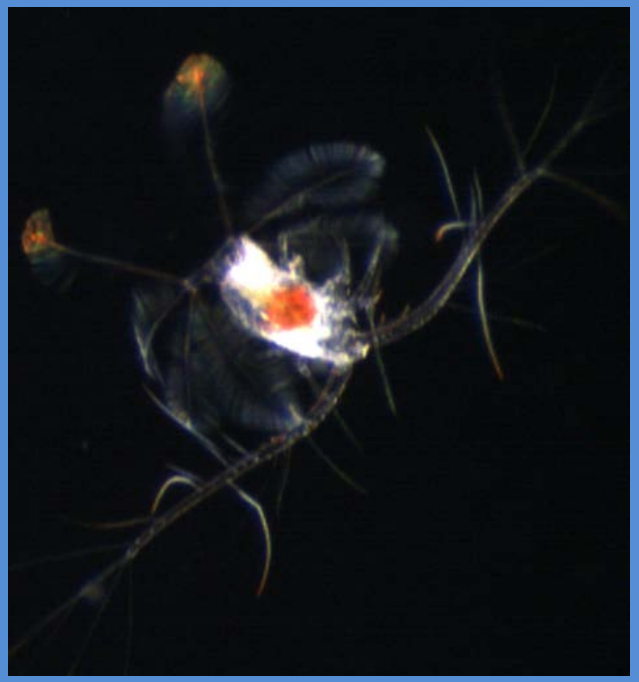
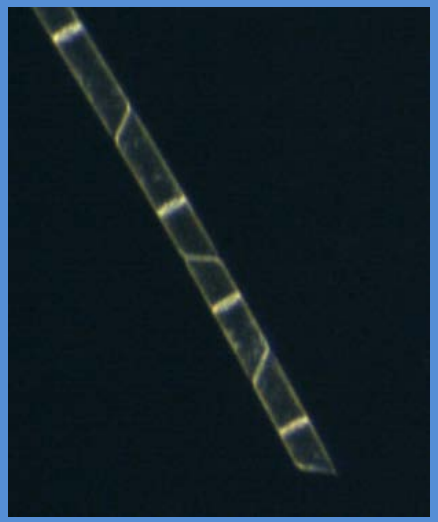
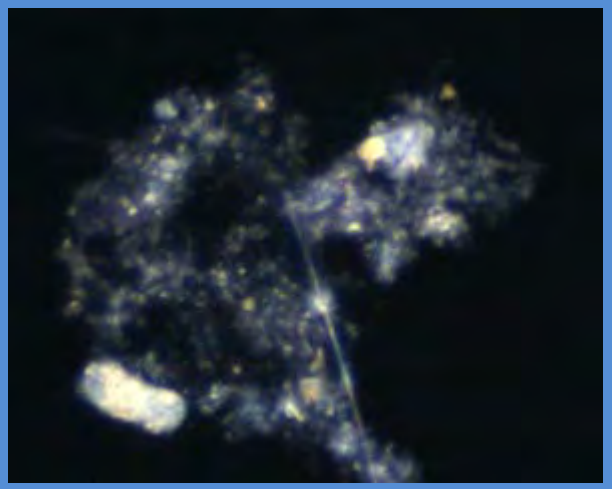


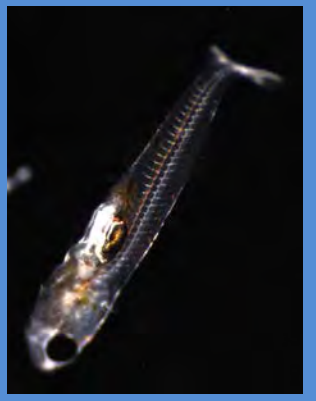










Automated Classification of Plankton

CPICS

Collect Images of Plankton

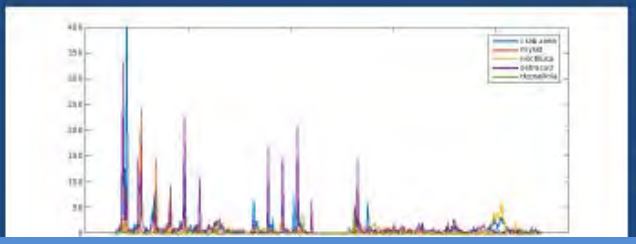
Develop Training Set
- Class 1
- Class2
- Class3 …

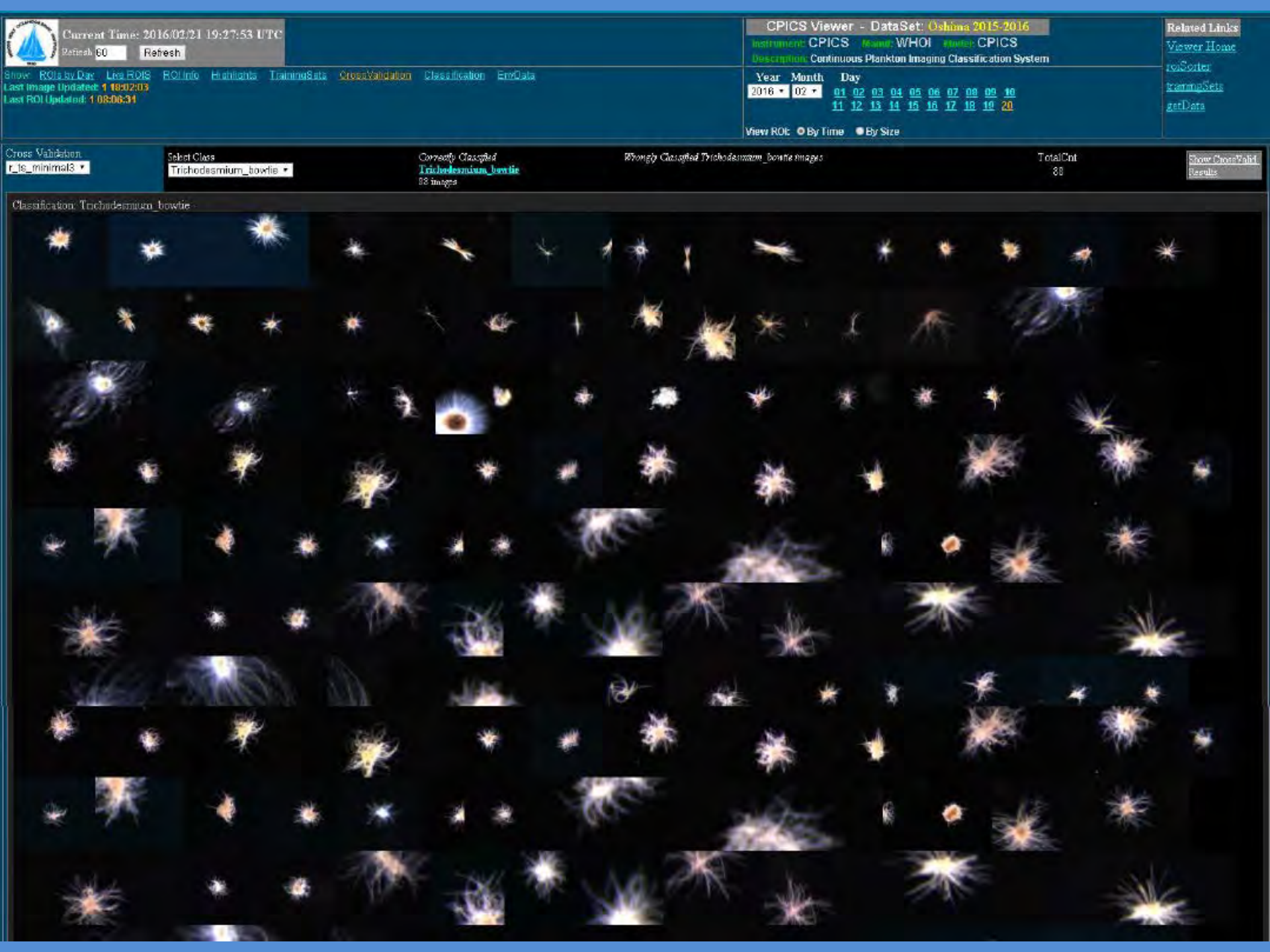
Feature extraction
- Gabor texture
- Color angles
- Shape
- Morphology

Classification
- Support Vector Machine
- Random Forest
- Linear Discriminate Analysis

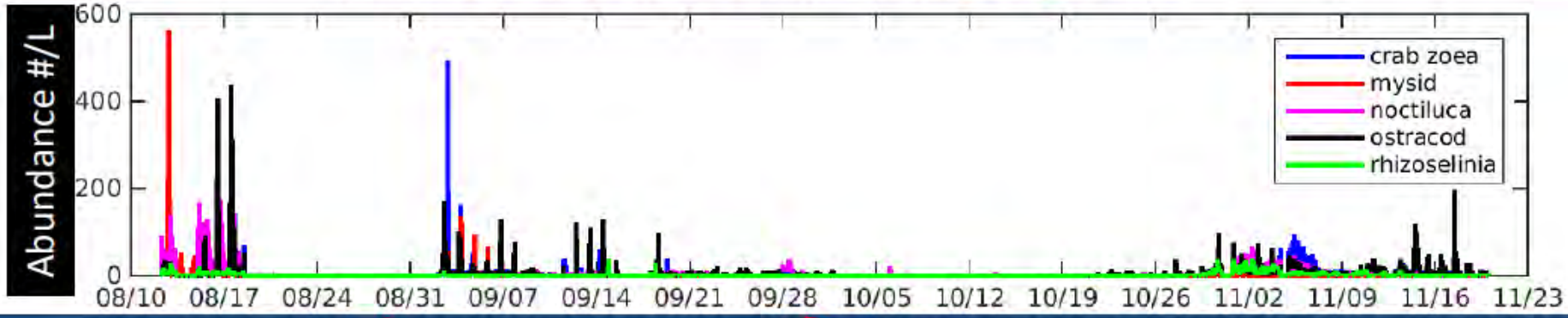
Evaluate the Classifier
Leave-one-out Cross Validation

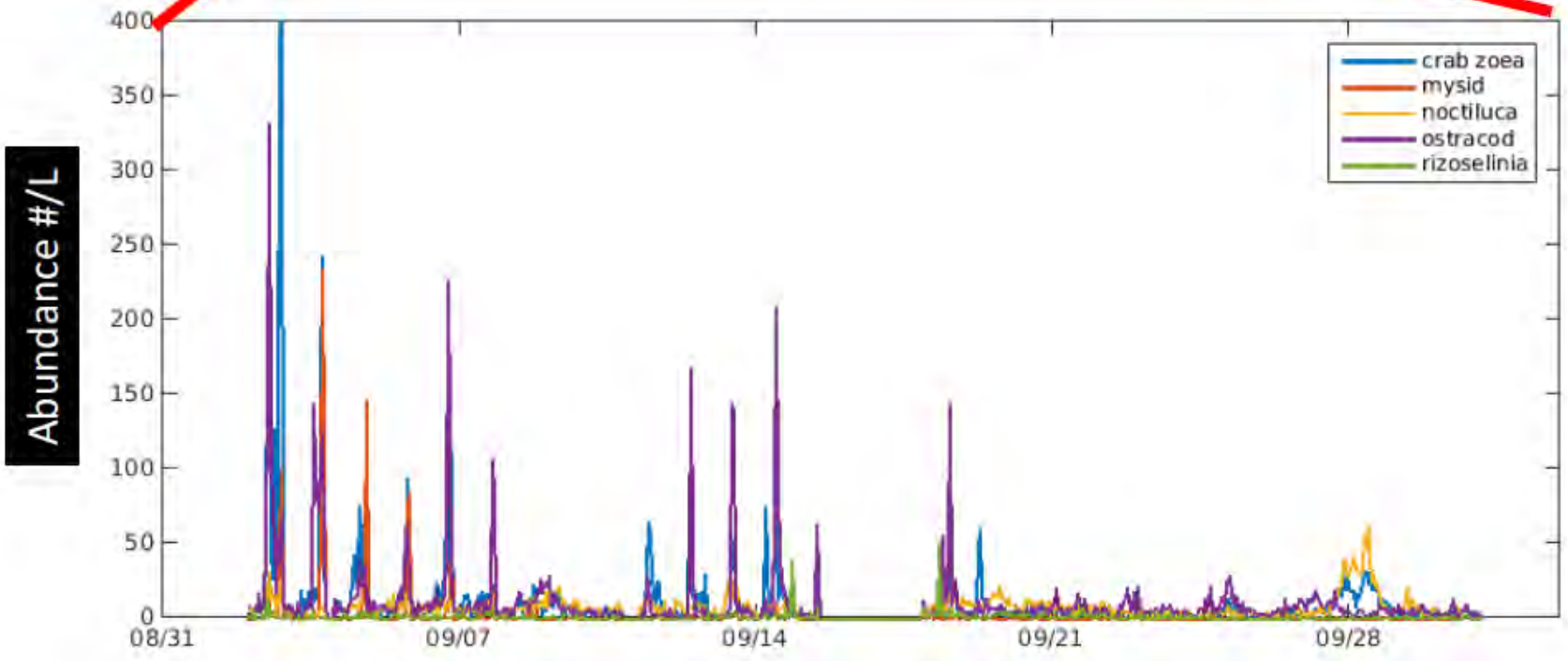
Plot Time Series

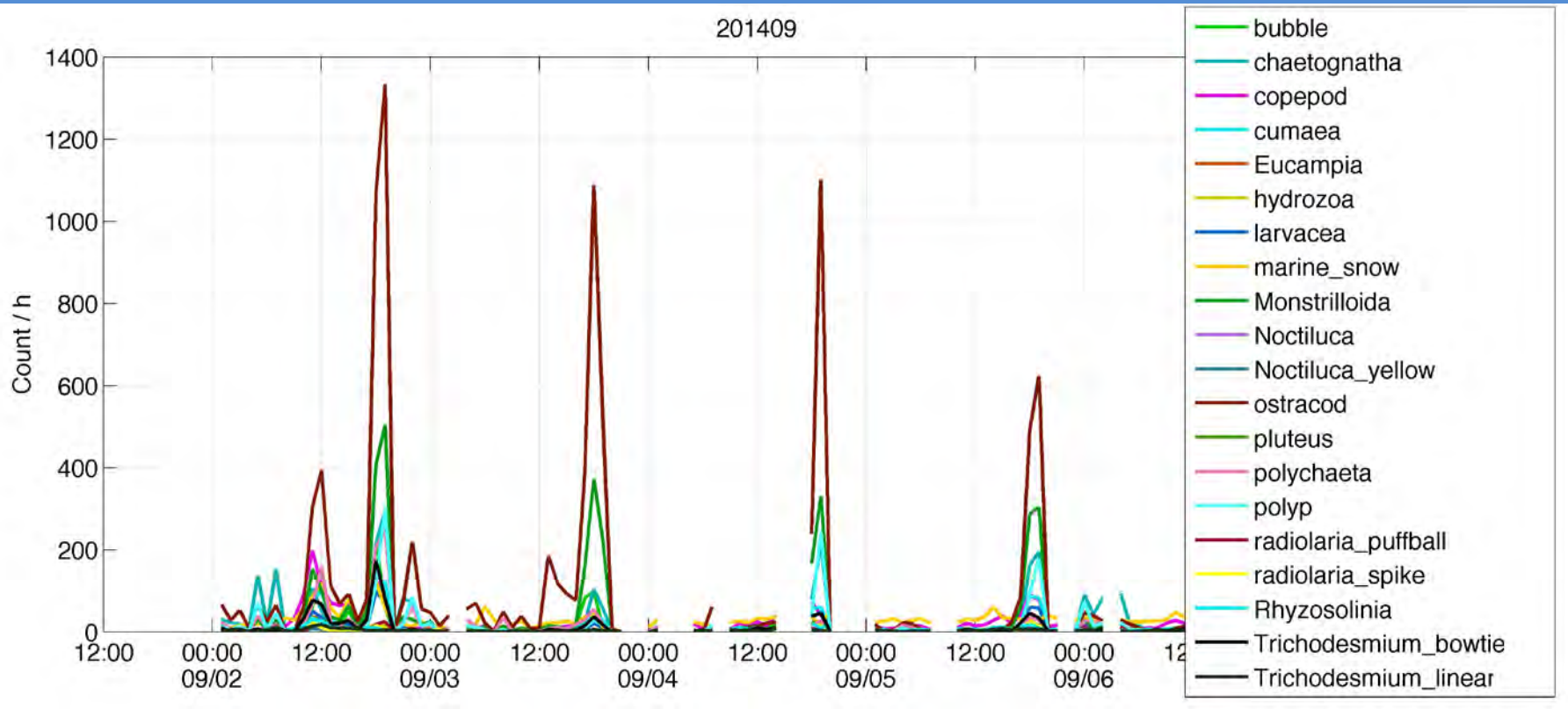



Current Time: 2016/02/21 19:27:53 UTC
Refresh 60
Refresh
CPICS Viewer - DataSet: Oshima 2015-2016
Instrument: CPICS Mount: WHOI Model: CPICS
Description: Continuous Plankton Imaging Classification System
Related Links
Viewer Home
roiSorter
trainingSets
getData
Show: ROIs by Day Live ROIS ROI Info Histograms TrainingSets CrossValidation Classification EnvData
Last Image Updated: 1 18:02:03
Last ROI Updated: 1 08:06:31
Year Month Day
2016 02
01 02 03 04 05 06 07 08 09 10
11 12 13 14 15 16 17 18 19 20
View ROI: By Time By Size
Cross Validation
r_ts_minimal3
Select Class
Trichodesmium_bowtie
Correctly Classified
Trichodesmium_bowtie
88 images
Wrongly Classified Trichodesmium_bowtie images
TotalCnt
88
Show CrossValid Results
Classification: Trichodesmium_bowtie

Plankton Time Series- Oshima Island, Tokyo. 2014






201409
Count / h
1400
1200
1000
800
600
400
200
0
12:00
00:00
09/02
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12:00
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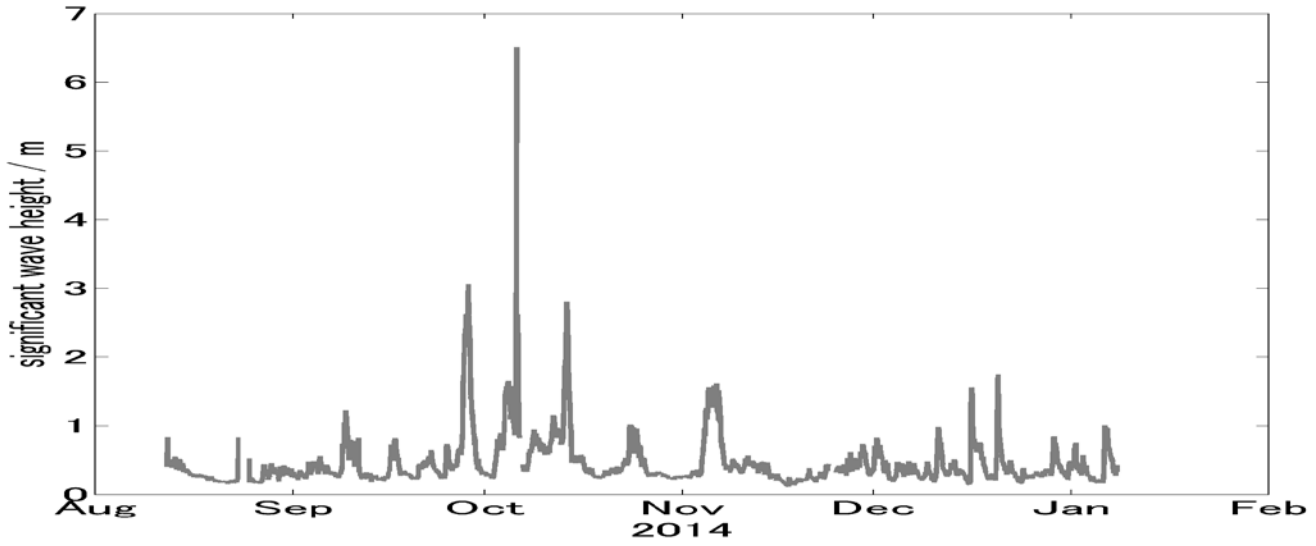
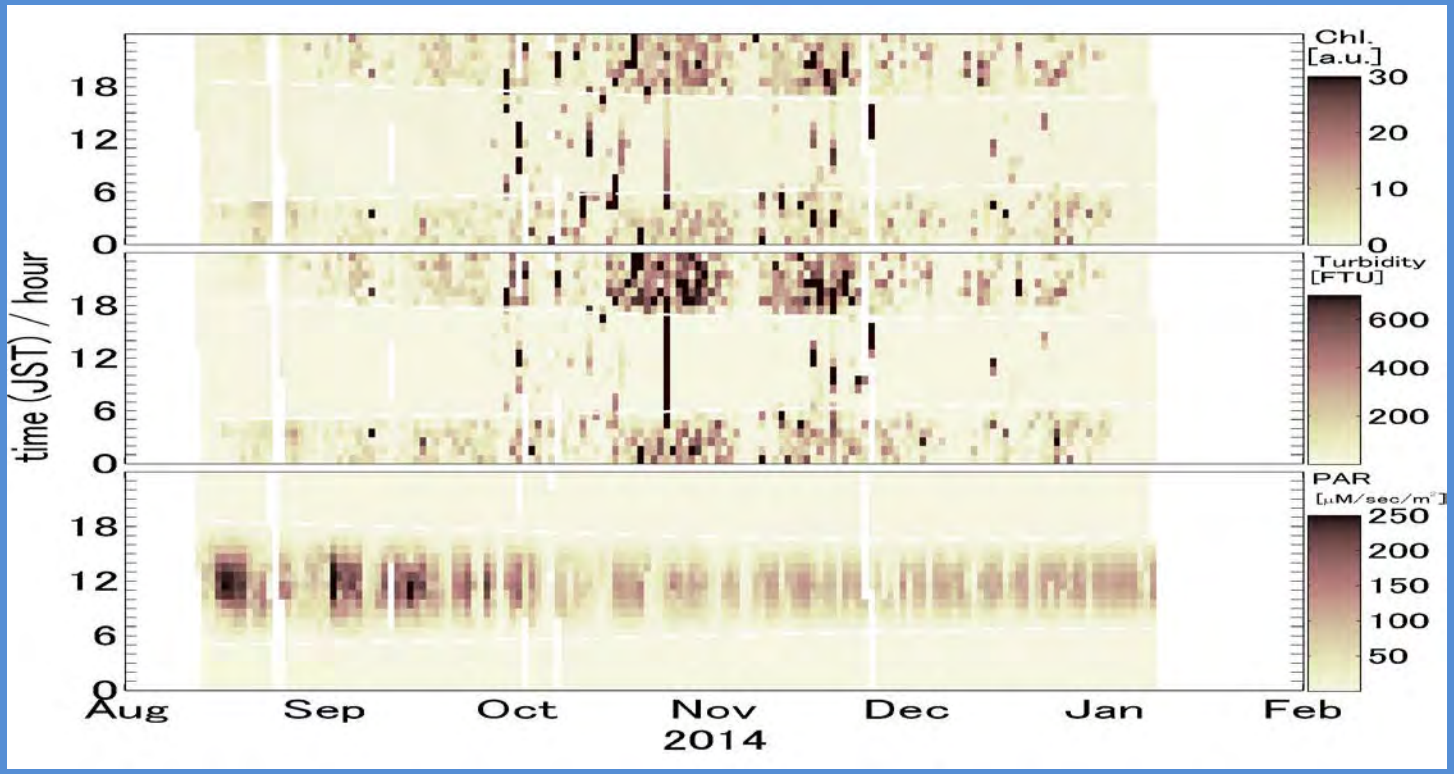
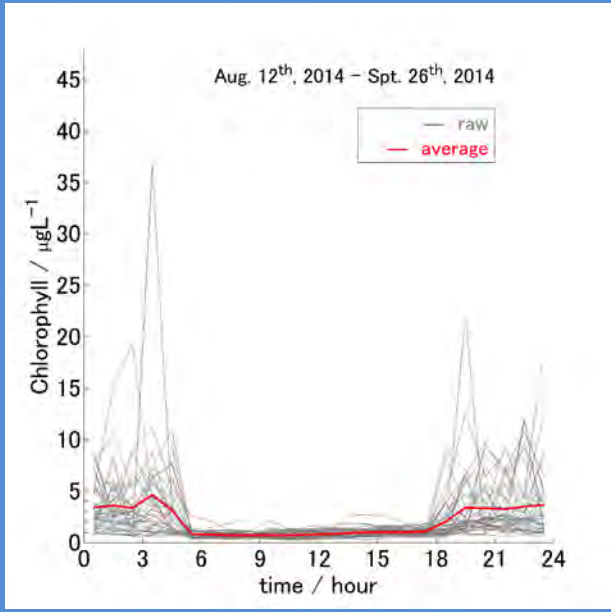
bubble
chaetognatha
copepod
cumaea
Eucampia
hydrozoa
larvacea
marine_snow
Monstrilloida
Noctiluca
Noctiluca_yellow
ostracod
pluteus
polychaeta
polyp
radiolaria_puffball
radiolaria_spike
Rhyzosolinia
Trichodesmium_bowtie
Trichodesmium_linear

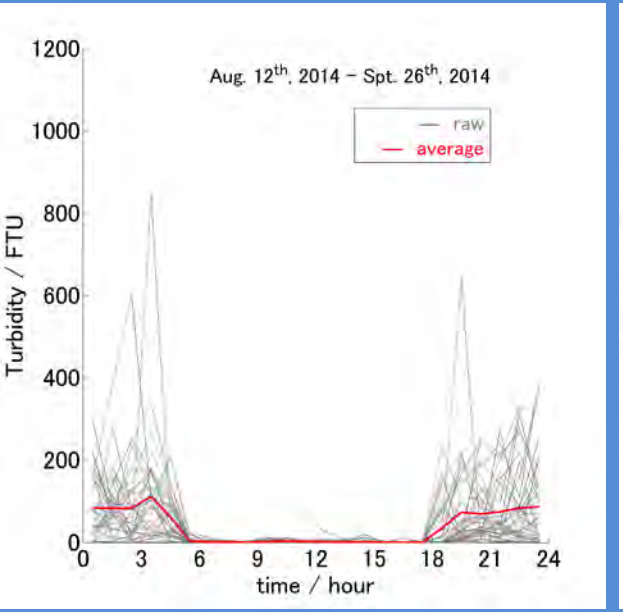

significant wave height / m
0
1
2
3
4
5
6
7
Aug
Sep
Oct
Nov
Dec
Jan
Feb
2014


time (JST) / hour
0
6
12
18
Chl.
[a.u.]
0
10
20
30
Turbidity
[FTU]
200
400
600
PAR
[μM/sec/m²]
50
100
150
200
250
Aug
Sep
Oct
Nov
Dec
Jan
Feb
2014

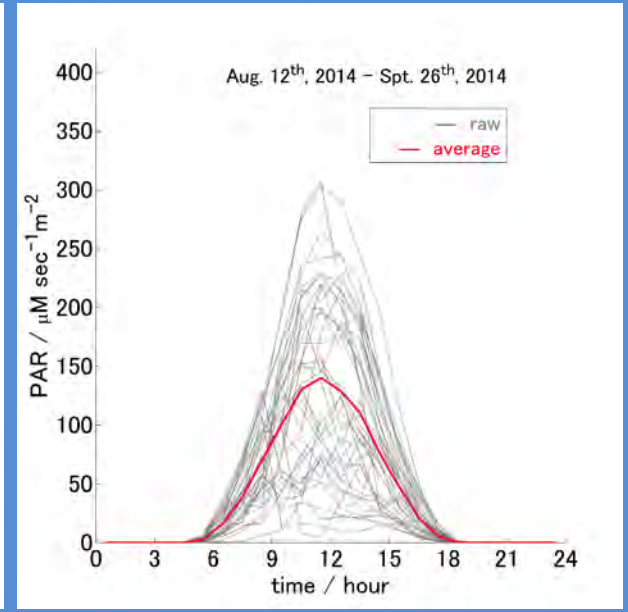
Chl



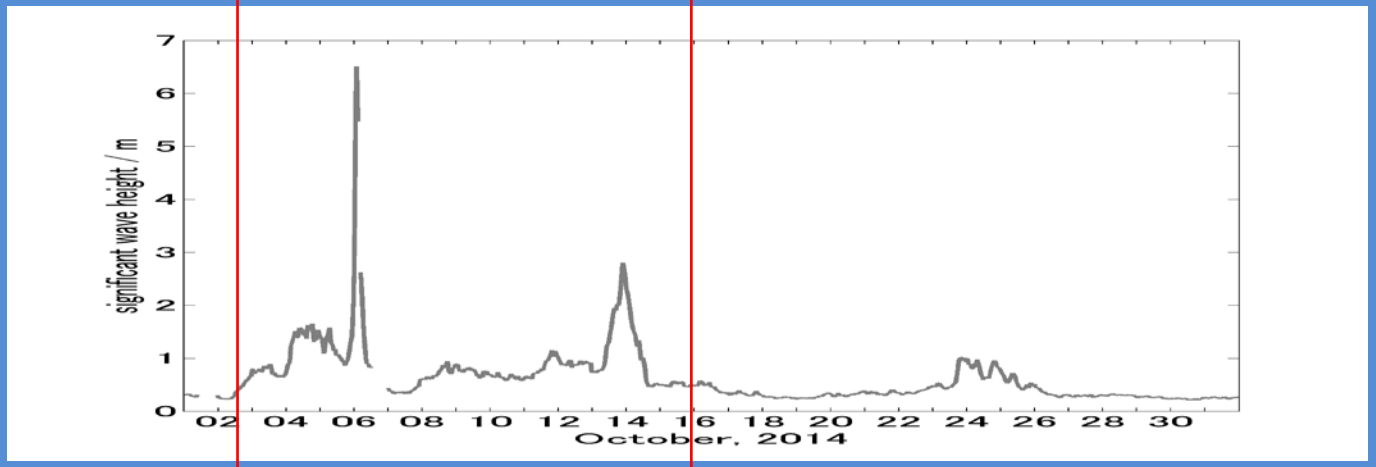
Turbidity



PAR



Wave height



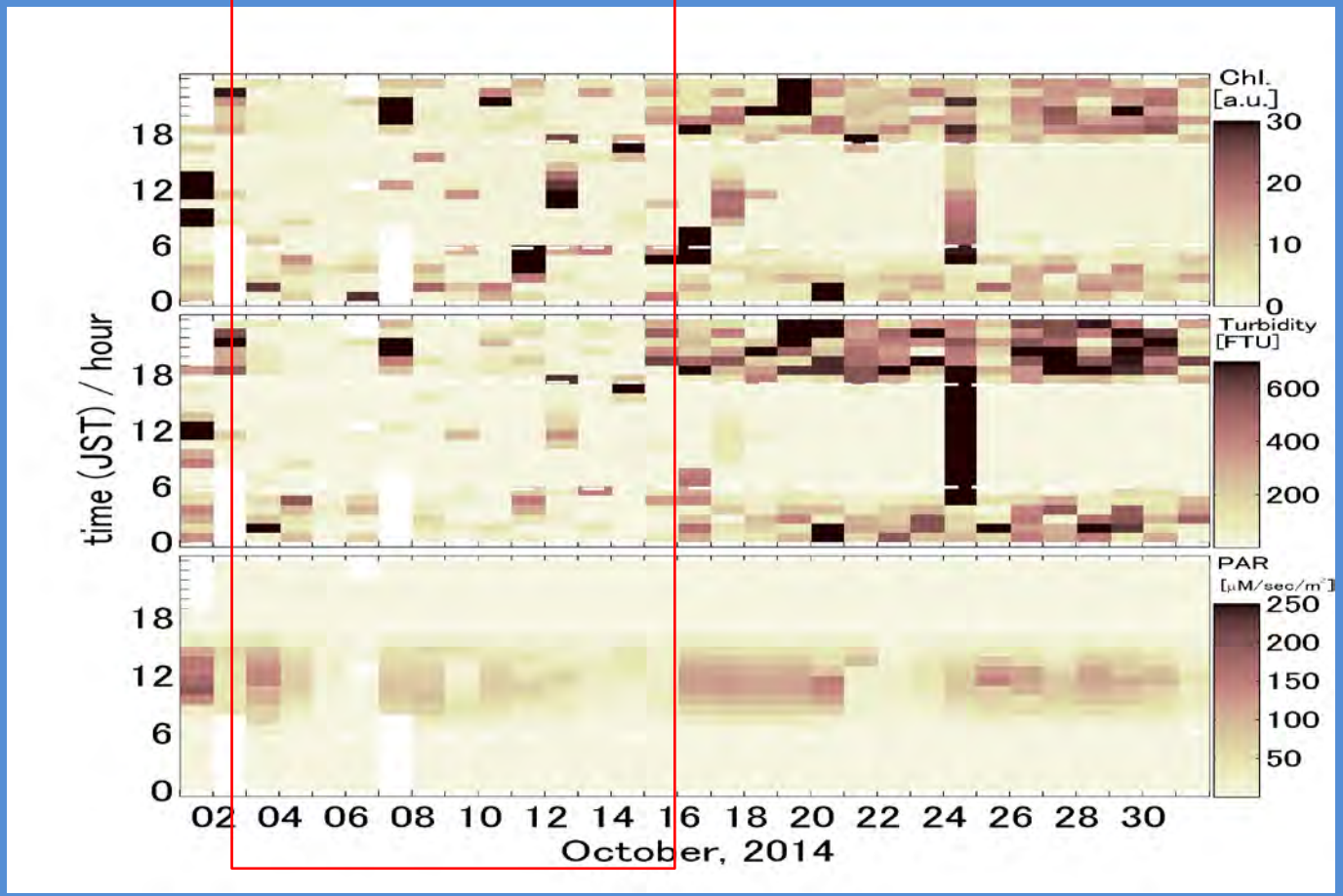
Aug.

Sept.

Oct.

Nov.

Dec.

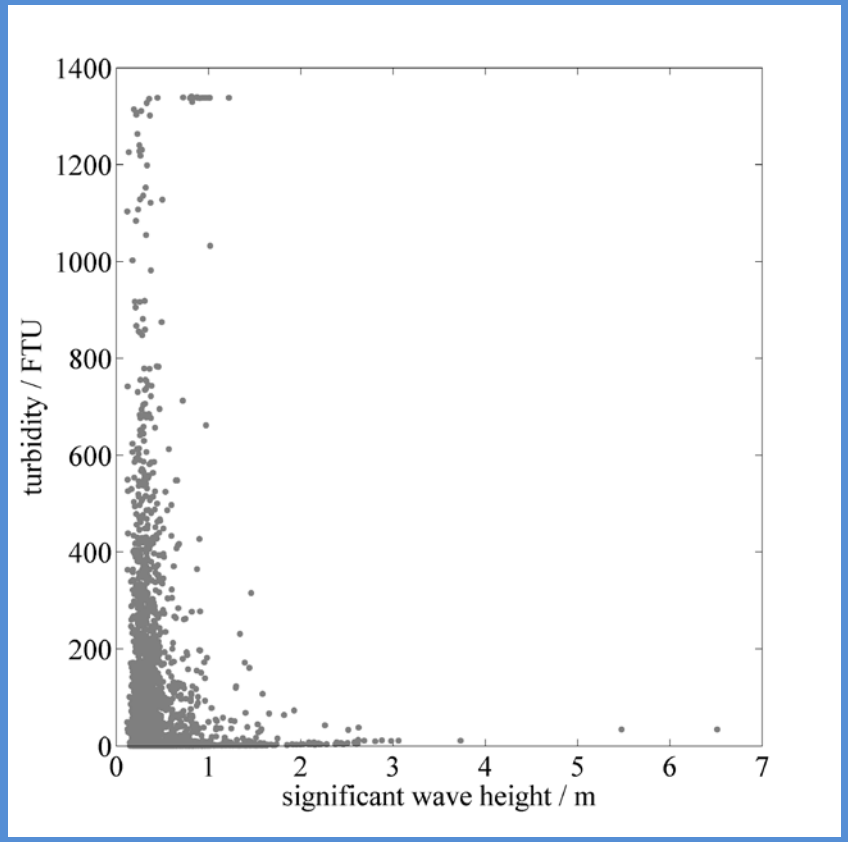


Chl.

Turbidity

PAR

wave height > 1 m: 5.7%

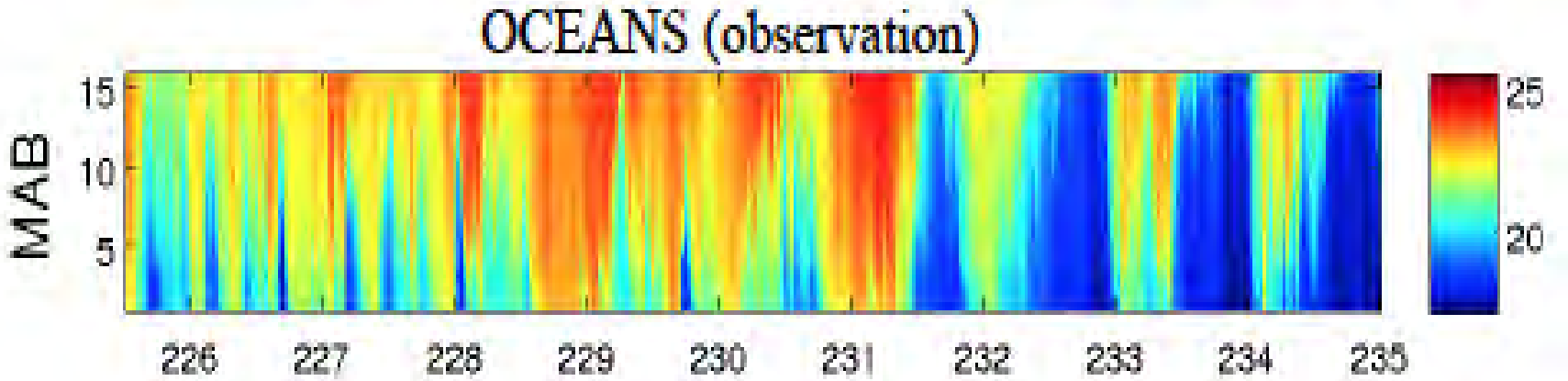


Turbidity

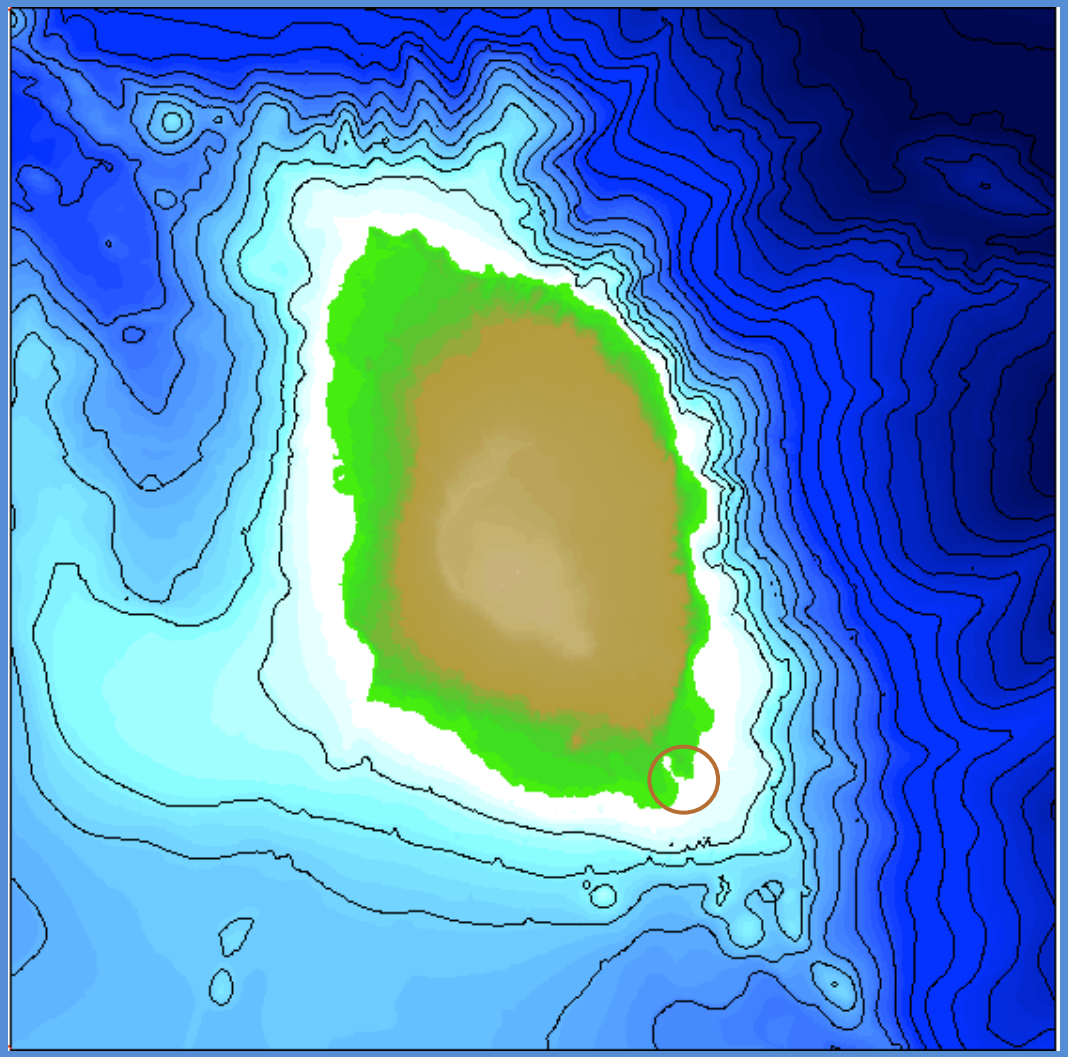
Wave height

Models

Observed data: Internal waves



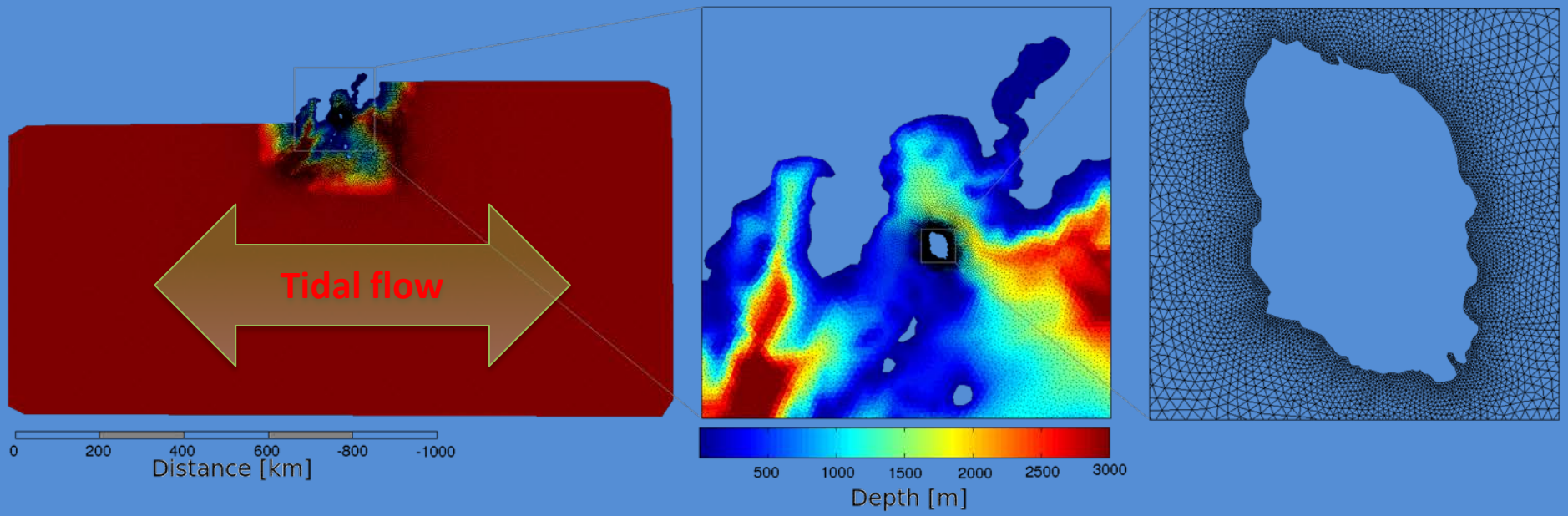
Thermistor chain data



Numerical Model

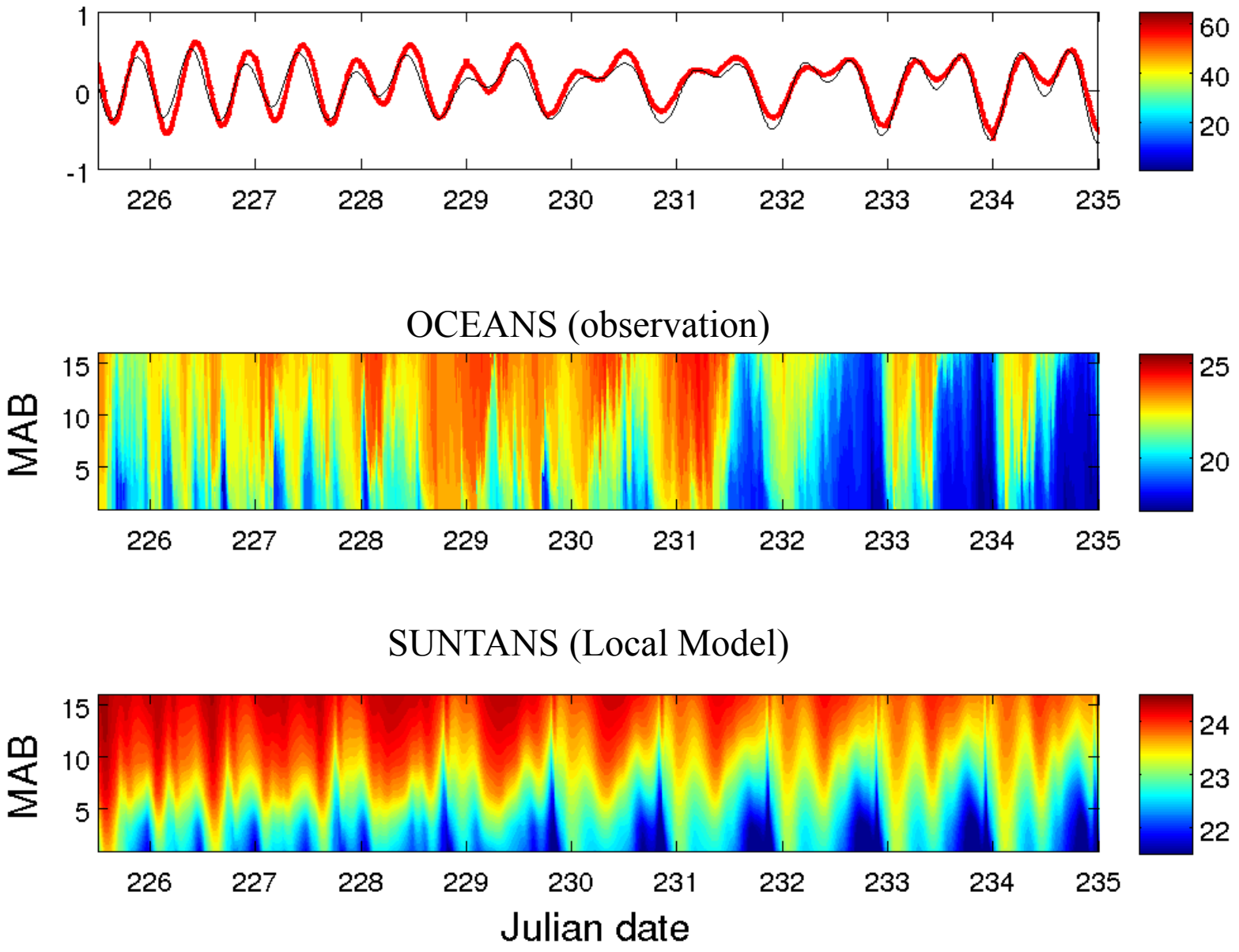
Model: SUNTANS (Fringer et al., 2006)

Grid: Unstructured grid. The maximum $\Delta x = 50$ km near the boundary and the minimum $\Delta x = 100$ m near the coast of Izu- Oshima Island.

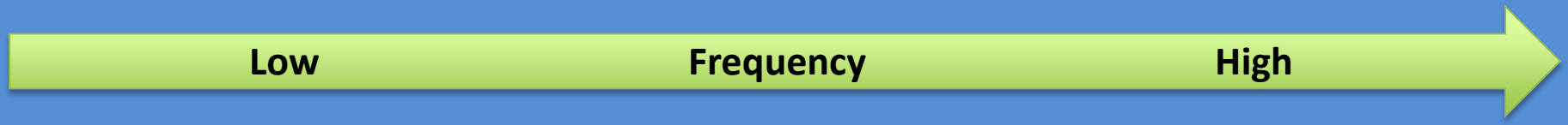


Forcing: Barotropic tidal forcing using 4 main tidal constituents (S2, M2, K1, O1)

Initial condition: Data from World Ocean Atlas.


1
0
-1
226
227
228
229
230
231
232
233
234
235
60
40
20
OCEANS (observation)
MAB
15
10
5
25
20
SUNTANS (Local Model)
24
23
22
Julian date

Oscillation of waves



$D < f < SD << N$

Diurnal tides

1/24 cph

Inertial frequency

1/20 cph

Semi-diurnal tides

1/12 cph

Buoyancy Frequency

Separated numerical simulations using diurnal and semidiurnal frequencies with constant tidal elevations.

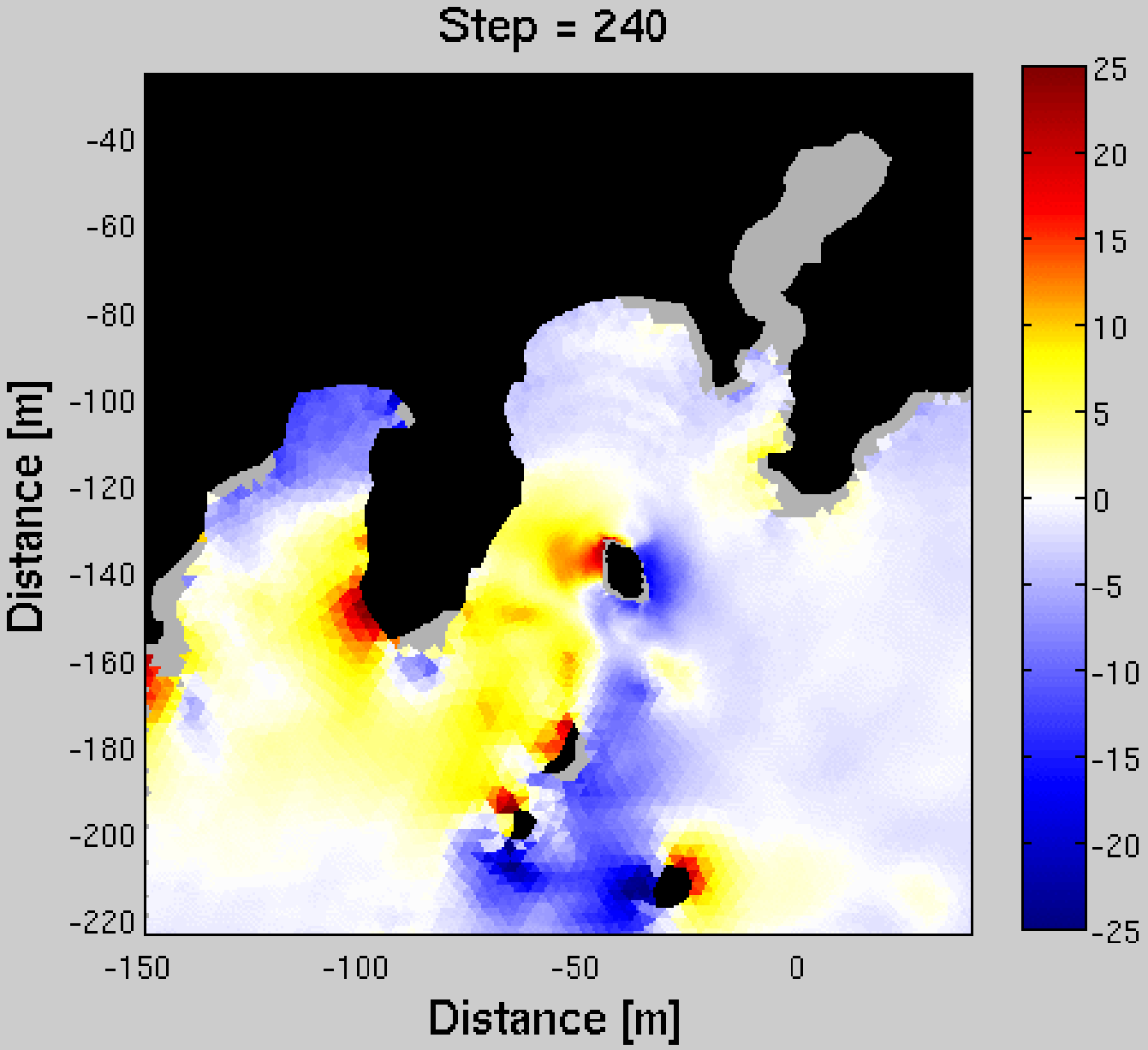
1. Run with K1 tides
$\sigma = 7.3 \times 10^{-5}$ rad/s
a = 0.5 m

2. Run with M2 tides
$\sigma = 1.4 \times 10^{-4}$ rad/s
a = 0.5 m

Submitted to *Journal of Physical Oceanography*

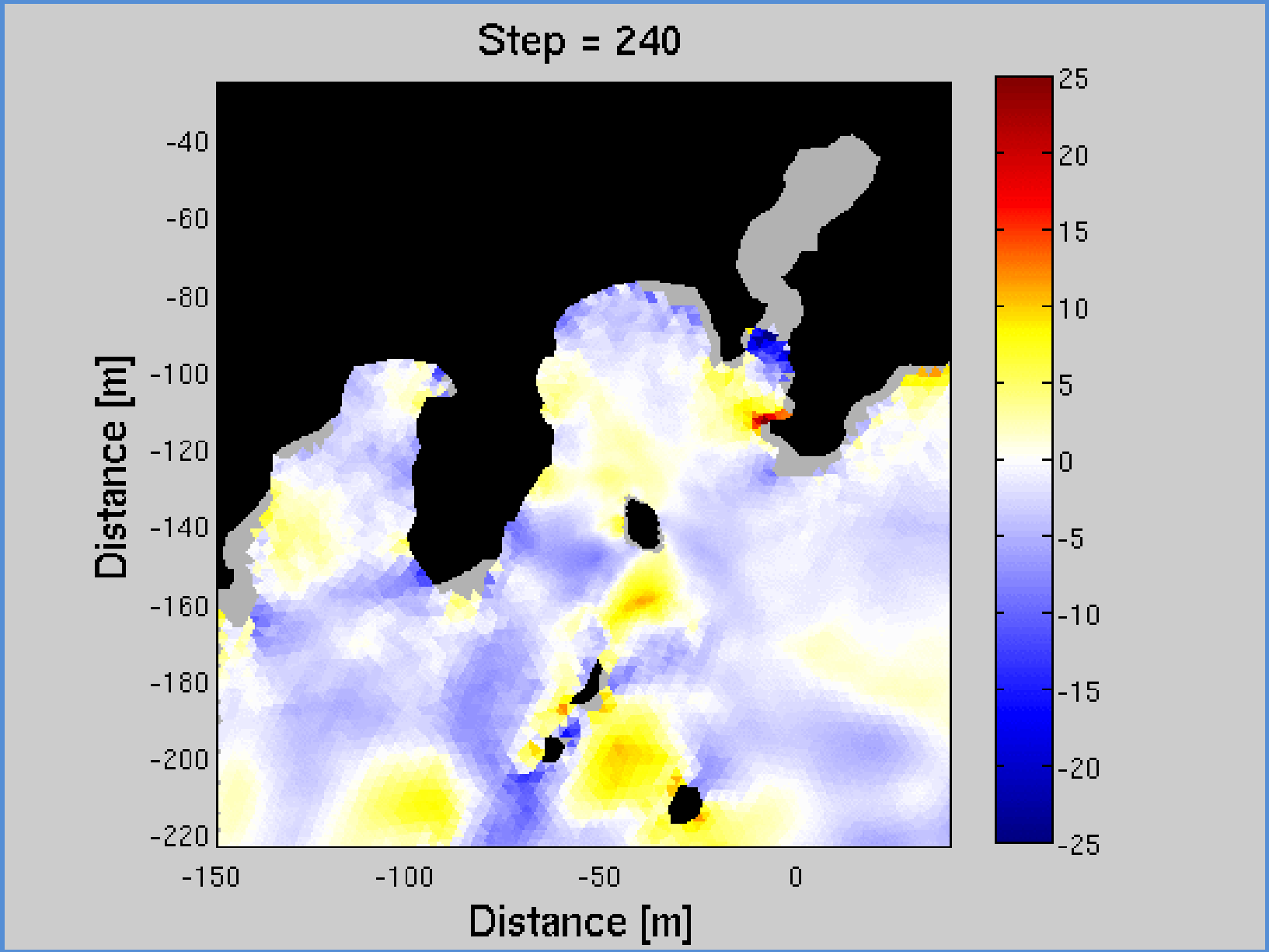
SUNTANS Results: K1 forcing

21 degrees isothermal displacement



SUNTANS Results: M2 forcing

21 degrees isothermal displacement



ROMS without tides

ROMS with tides