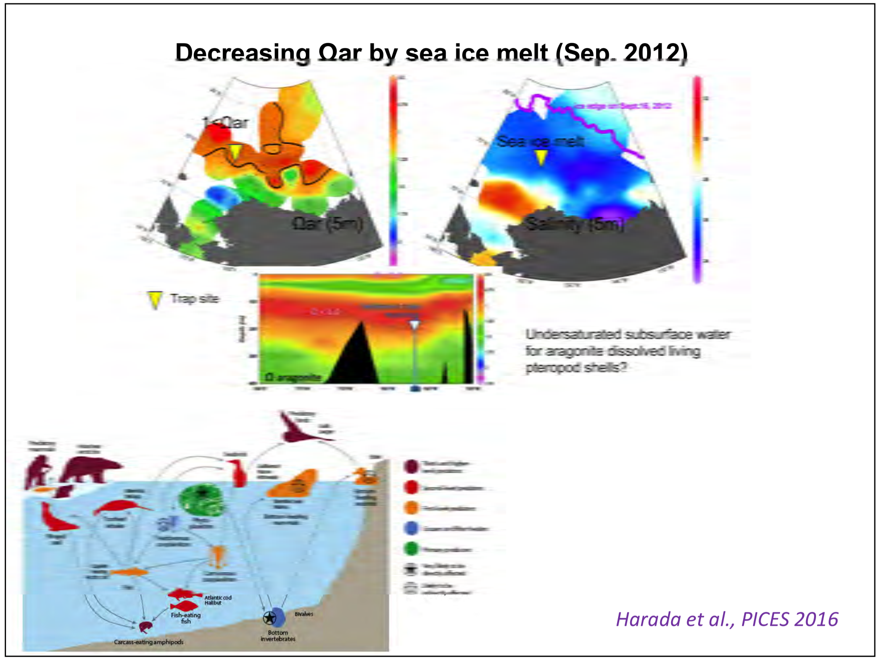
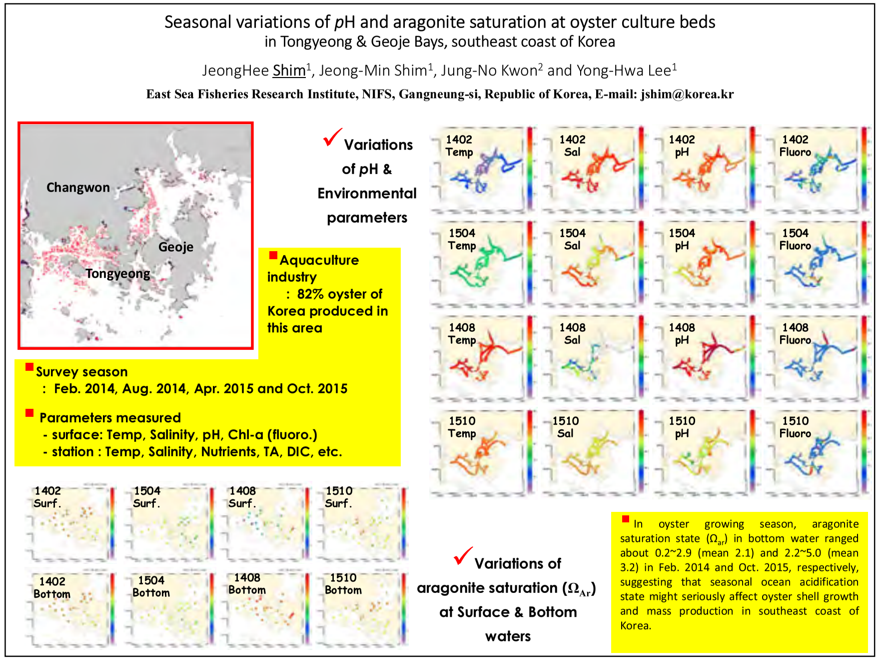
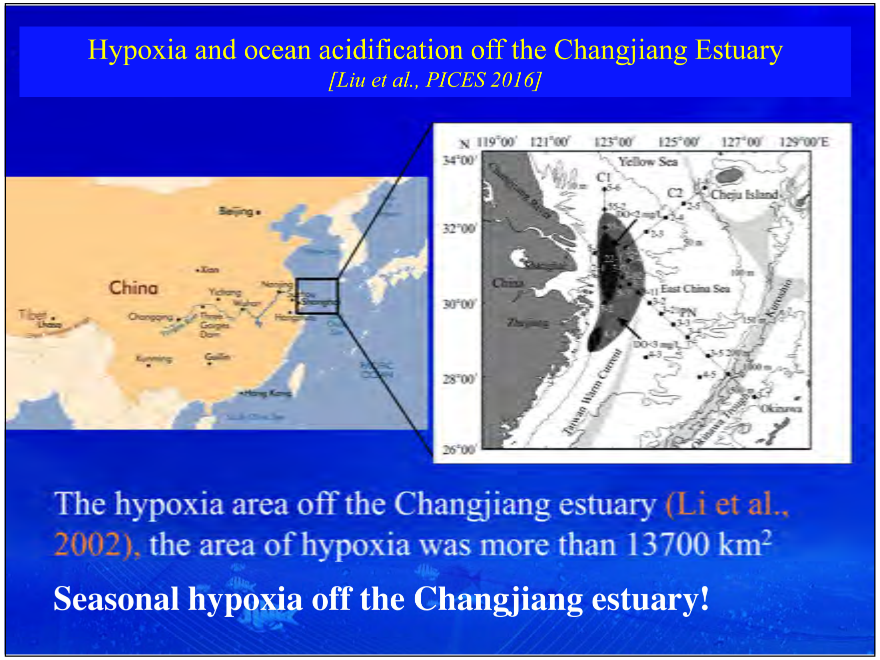
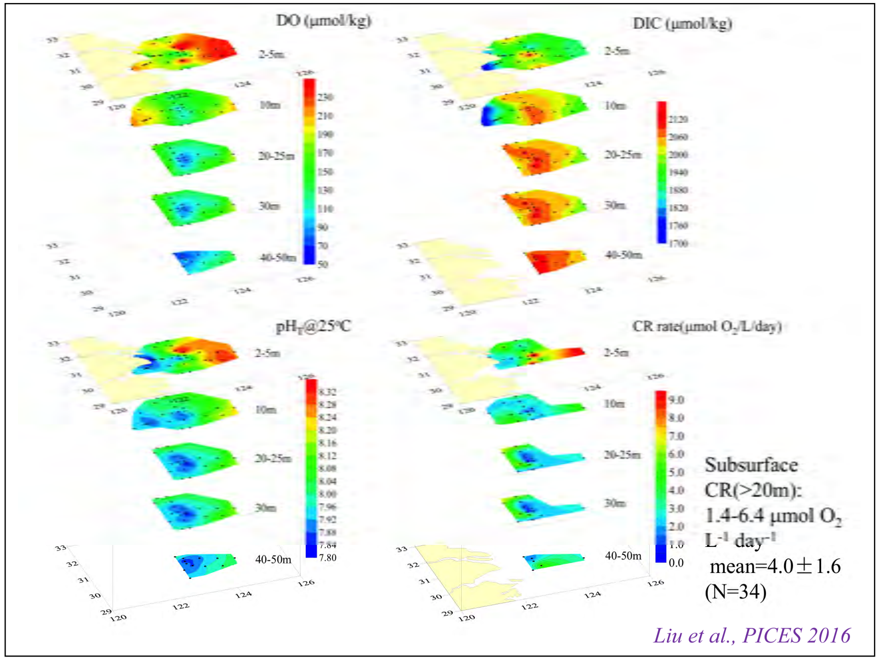
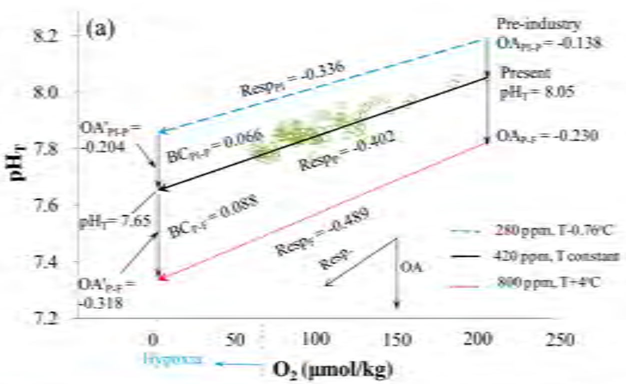

Decreasing Ωar by sea ice melt (Sep. 2012)
Ωar (5m)
Salinity (5m)
Sea ice melt
Trap site
Undersaturated subsurface water for aragonite dissolved living pteropod shells?
Harada et al., PICES 2016


Seasonal variations of pH and aragonite saturation at oyster culture beds
in Tongyeong & Geoje Bays, southeast coast of Korea
JeongHee Shim1, Jeong-Min Shim1, Jung-No Kwon2 and Yong-Hwa Lee1
East Sea Fisheries Research Institute, NIFS, Gangneung-si, Republic of Korea, E-mail: jshim@korea.kr
Changwon
Geoje
Tongyeong
Variations of pH & Environmental parameters
Aquaculture industry : 82% oyster of Korea produced in this area
Survey season : Feb. 2014, Aug. 2014, Apr. 2015 and Oct. 2015
Parameters measured
- surface: Temp, Salinity, pH, Chl-a (fluoro.)
- station : Temp, Salinity, Nutrients, TA, DIC, etc.
1402 Temp
1402 Sal
1402 pH
1402 Fluoro
1504 Temp
1504 Sal
1504 pH
1504 Fluoro
1408 Temp
1408 Sal
1408 pH
1408 Fluoro
1510 Temp
1510 Sal
1510 pH
1510 Fluoro
1402 Surf.
1504 Surf.
1408 Surf.
1510 Surf.
1402 Bottom
1504 Bottom
1408 Bottom
1510 Bottom
Variations of aragonite saturation (Ω_{Ar}) at Surface & Bottom waters
In oyster growing season, aragonite saturation state (Ω_{ar}) in bottom water ranged about 0.2~2.9 (mean 2.1) and 2.2~5.0 (mean 3.2) in Feb. 2014 and Oct. 2015, respectively, suggesting that seasonal ocean acidification state might seriously affect oyster shell growth and mass production in southeast coast of Korea.


Hypoxia and ocean acidification off the Changjiang Estuary
[Liu et al., PICES 2016]
China
Beijing
Yellow Sea
Cheju Island
East China Sea
Taiwan Warm Current
Okinawa
The hypoxia area off the Changjiang estuary (Li et al., 2002), the area of hypoxia was more than 13700 km^2
Seasonal hypoxia off the Changjiang estuary!


DO (μmol/kg)
DIC (μmol/kg)
pH$_T$@25°C
CR rate(μmol O$_2$/L/day)
2-5m
10m
20-25m
30m
40-50m
Subsurface CR(>20m): 1.4-6.4 μmol O$_2$ L^{-1} day^{-1}
mean=4.0±1.6 (N=34)
Liu et al., PICES 2016



The relationships between subsurface DO and pH under pre-industrial (or PI, light blue dashed line), present (or P, dark solid line) and future (or F, red dashed line) CO_2 condition and temperature. The changes of temperature and CO_2 levels are according to IPCC (2007). pH drawdown due to uptake of anthropogenic CO_2 (or ocean acidification, OA), respiration (Resp.) and weakening carbonate buffer capacity (BC) were shown respectively. In the model, all the data points from the survey in August 2011 with salinity > 31, depth > 10m were presented. Assumed that CR was not influenced by temperature, and under DO-depleted scenarios.

Liu et al., PICES 2016

The State of North Pacific Ocean Acidification

- a Basin-Scale Synthesis Report

(1) History and context
・The North Pacific Ocean and its marginal seas
・Oceanography: why is the North Pacific particularly vulnerable to OA?
・Benchmark observations regarding anthropogenic carbon in the Pacific (e.g., HOT, Line P, JMA lines, POI pH time series)
・Contributions of different PICES member countries

(2) The challenge of the future
a) rate of change and inadequacy of baseline observations
b) carbon chemistry is more complex and less well constrained in nearshore waters where major impacts occur
c) many, many potentially vulnerable species: not enough resources to evaluate all potential impacts

(3) Individual member country reports
Canada
Japan
People's Republic of China
Republic of Korea
Russian Federation
United States

#We envision these as containing:
- inventory of historical, ongoing or planned observing programs
- important historical trends not covered in (1)
- inventory of known impacts
- any particularly exciting science highlights

North Pacific OA Synthesis Report
Will be published in Autumn 2017
as PICES Scientific Report.

Session 3-2

"Coastal Temperature & OA Monitoring Strategy for the USP Region – Present Status and Future Plans"

Antoine de Ramon N' Yeurt

Marine Biologist and Algal Taxonomist Lecturer,

University of the South Pacific (USP)

Dr. Antoine de Ramon N'Yeurt obtained his PhD in marine botany from the University of the South Pacific (USP, Suva) in 1998, and is currently a Lecturer in climate-change issue at the Pacific Centre for Environment and Sustainable Development (PACE-SD) of the University of the South Pacific in Fiji.

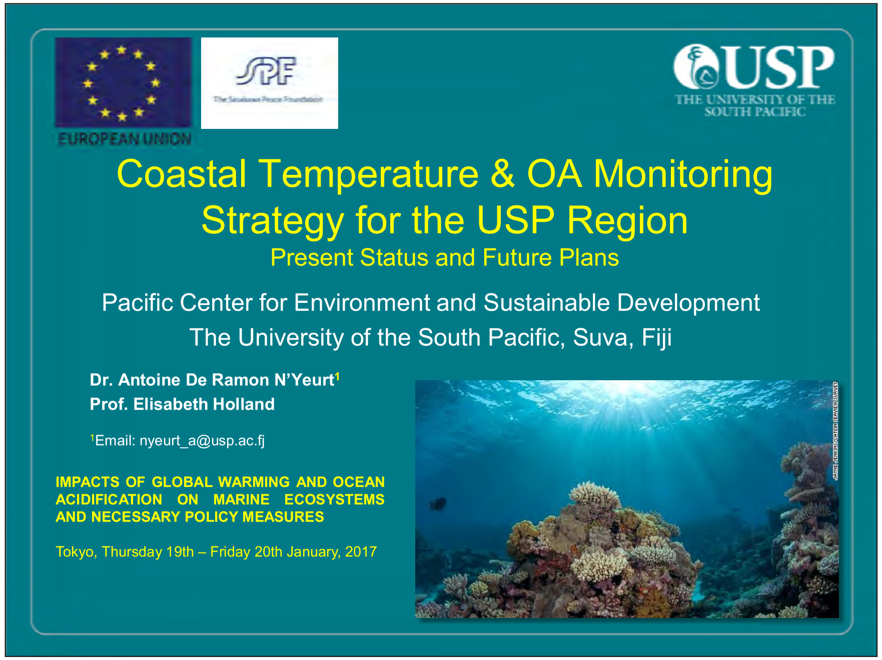
For the last 20 years he devoted his activities to the study of marine algae of the Pacific Islands such as Fiji, Rotuma, the Cook Islands, and has been involved in surveys of the marine floras of French Polynesia, Wallis, the Solomon Islands, Santo (Vanuatu), the Seychelles and Clipperton.

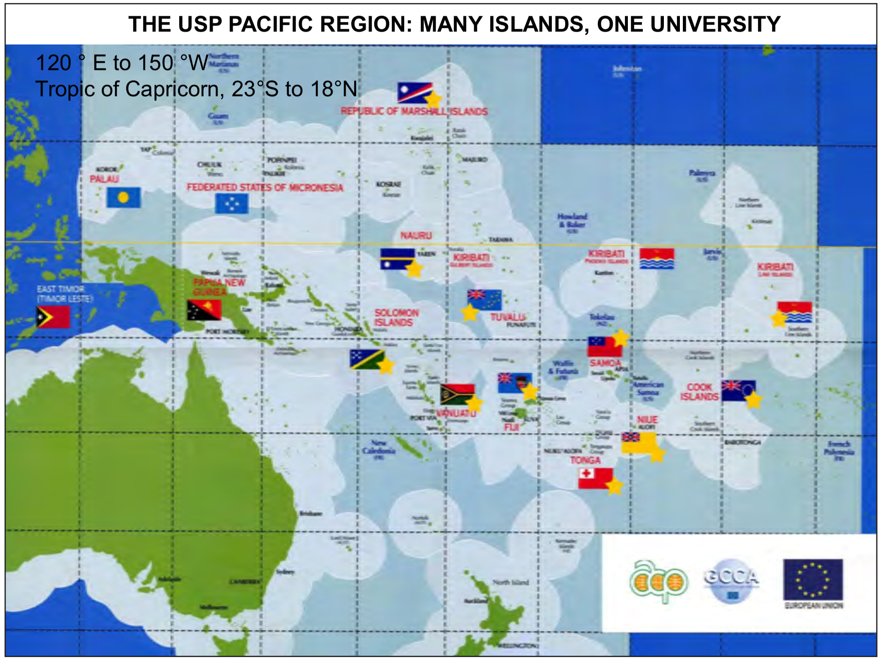
He is the author of numerous publications, books and floras on taxonomy and described several new genera and species of marine algae.

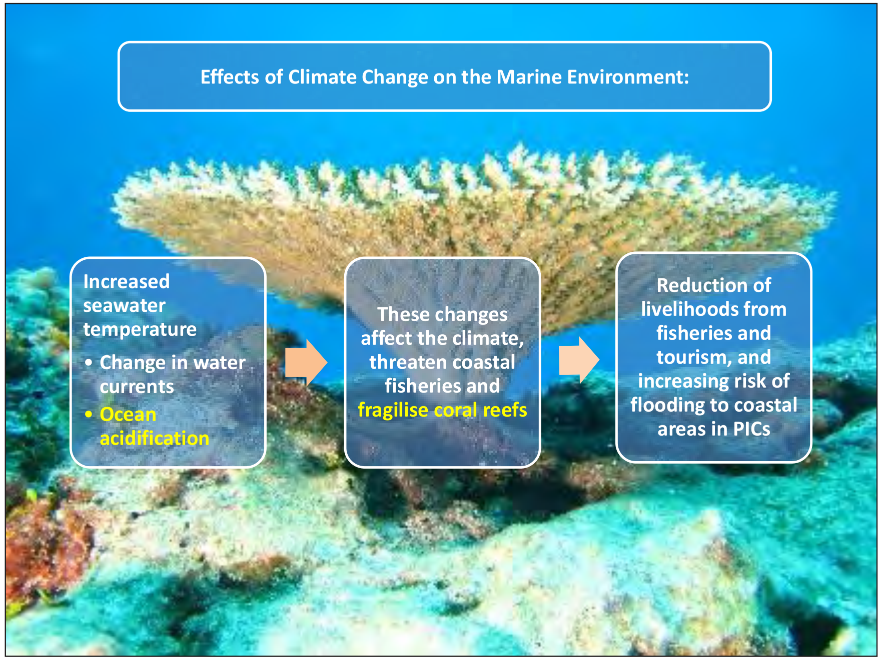
Since 2012, he is the coordinator for PC426 (Pacific Ecology in Relation to Climate Change), a fully-online postgraduate course at the University of the South Pacific.

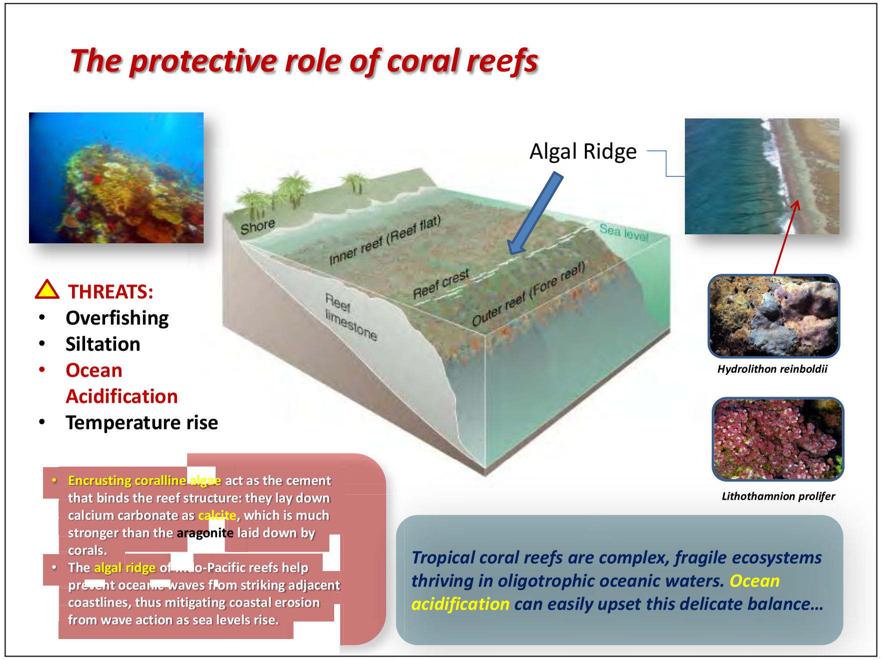
More recently, he has been involved in the topics of Ocean Algal Afforestation (OAA) and renewable energy, bio-fertilisers and ocean acidification and its effects on coral reefs.

He is also involved in population-level climate change adaptation in the South Pacific, and manages a network of coastal observation platforms for seawater temperature and ocean acidification in Fiji. Since 2012, Dr. N'Yeurt has co-supervised more than 10 Masters and PhD students.


EUROPEAN UNION
SPF
The Sasakawa Peace Foundation
USP
THE UNIVERSITY OF THE SOUTH PACIFIC
Coastal Temperature & OA Monitoring Strategy for the USP Region
Present Status and Future Plans
Pacific Center for Environment and Sustainable Development
The University of the South Pacific, Suva, Fiji
Dr. Antoine De Ramon N'Yeurt[1]
Prof. Elisabeth Holland
[1]Email: nyeurt_a@usp.ac.fj
IMPACTS OF GLOBAL WARMING AND OCEAN ACIDIFICATION ON MARINE ECOSYSTEMS AND NECESSARY POLICY MEASURES
Tokyo, Thursday 19th – Friday 20th January, 2017


THE USP PACIFIC REGION: MANY ISLANDS, ONE UNIVERSITY
120 ° E to 150 °W
Tropic of Capricorn, 23°S to 18°N
REPUBLIC OF MARSHALL ISLANDS
PALAU
FEDERATED STATES OF MICRONESIA
NAURU
KIRIBATI
EAST TIMOR (TIMOR LESTE)
PAPUA NEW GUINEA
SOLOMON ISLANDS
TUVALU
SAMOA
VANUATU
FIJI
COOK ISLANDS
NIUE
TONGA
GCCA
EUROPEAN UNION


Effects of Climate Change on the Marine Environment:
Increased seawater temperature
• Change in water currents
• Ocean acidification
These changes affect the climate, threaten coastal fisheries and fragilise coral reefs
Reduction of livelihoods from fisheries and tourism, and increasing risk of flooding to coastal areas in PICs

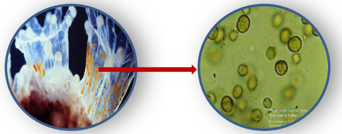

The protective role of coral reefs
Algal Ridge
Shore
Inner reef (Reef flat)
Reef crest
Outer reef (Fore reef)
Reef limestone
Sea level
THREATS:
• Overfishing
• Siltation
• Ocean Acidification
• Temperature rise
Hydrolithon reinboldii
Lithothamnion prolifer
• Encrusting coralline act as the cement that binds the reef structure: they lay down calcium carbonate as calcite, which is much stronger than the aragonite laid down by corals.
• The algal ridge of o-Pacific reefs help waves from striking adjacent coastlines, thus mitigating coastal erosion from wave action as sea levels rise.
Tropical coral reefs are complex, fragile ecosystems thriving in oligotrophic oceanic waters. Ocean acidification can easily upset this delicate balance...

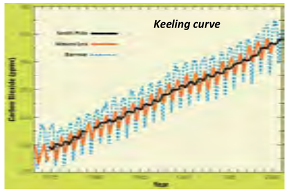
Ocean Acidification

pH 8.0 → 7.7*

* IPCC IS92a CO2 emission scenario

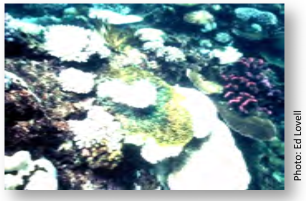
How would coral reefs be affected by higher water temperature and higher dissolved CO_2?



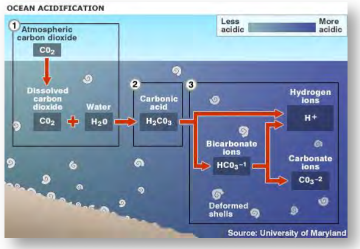


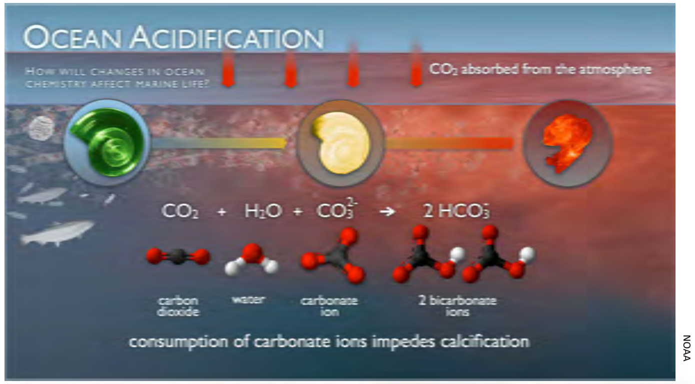
Global CO2 levels have risen steadily since the 1800's

- *Coral bleaching and death occurs at the threshhold temperature of 29°C as corals expel symbiotic microalgae (zooxanthellae) which supply up to 90% of the coral's energy*
- *Higher dissolved CO_2 leads to a decrease in pH (H+ ions) and fragilisation of the reef structure due to a decrease in calcification rate of corals, coralline algae and other reef organisms —> more coastal erosion*



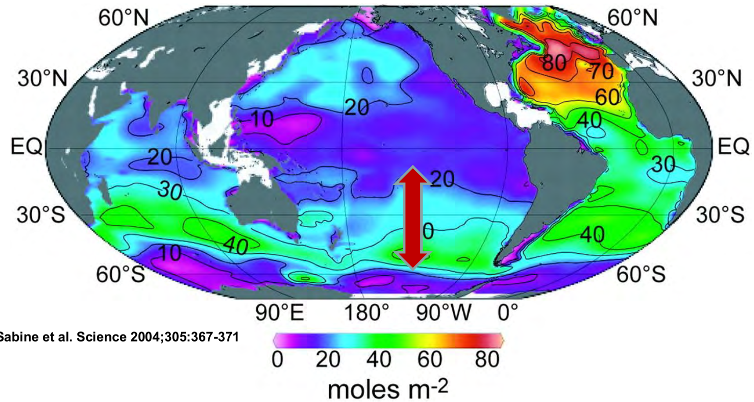
Year 2000 Mass Bleaching Event in Fiji





The photos above show what happens to a marine pteropod's shell when placed in sea water with pH and carbonate levels projected for the year 2100. The shell slowly dissolves after 45 days. *Photo credit: National Geographic Images*

Column inventory of anthropogenic CO_2 in the ocean



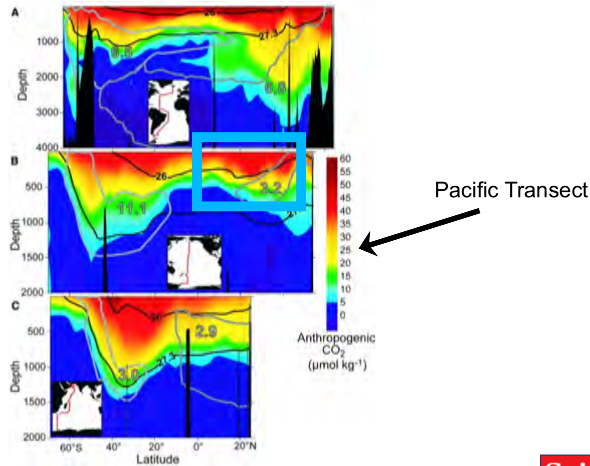
C L Sabine et al. Science 2004;305:367-371

- "More than 40% of the global inventory is found in the region between 50°S and 14°S"
- This includes many PICs in the USP Region.

Science AAAS

Published by AAAS

Representative sections of anthropogenic CO2 (μmol kg–1) from (A) the Atlantic, (B) Pacific, and Indian (C) oceans.



C L Sabine et al.
Science 2004;305:367-371

Science AAAS

Published by AAAS

NET CARBON EMISSIONS BY SMALL ISLAND STATES

Country	~ EEZ Area (km²)	Ocean Carbon Sink[1,2]	Emissions Including forest uptake[1,3]	Net carbon emissions[1,4]
Cook Islands	1,830,000	-46.51	-0.11	-46.61
Fiji	1,290,000	-32.79	-6.3	-39.09
FSM	2,987,000	-91.75	1.46	-90.29
Kiribati	3,550,000	-90.23	0.02	-90.21
Marshall Islands	2,131,000	-54.16	0.00	-54.16
Nauru	320,000	-8.13	0.02	-8.11
Niue	390,000	-9.91	3.40	-6.51
Palau	629,000	-15.99	-0.42	-16.40
PNG	3,120,000	-79.30	1.6	-77.70
Samoa	120,000	-3.05	-6.08	-9.13
Solomon Islands	1,340,000	-34.06	0.03	-34.03
Tonga	700,000	-17.79	-1.74	-19.53
Tuvalu	900,000	-22.87	0.00	-22.87
Vanuatu	680,000	-17.28	0.01	-40.15
TOTAL	**19,978,000**	**-507.75**	**-8.11**	**-515.86**

[1] Million metric tons Carbon dioxide=10^{12} g of CO_2 per year
[2] =Global C Sink*EEZ/ total ocean area
[3] Emissions from the First or Second National Climate Change Communication as available
[4] Net emissions=ocean sink-emissions

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What are Pacific Islands NET Carbon Emissions?

USP THE UNIVERSITY OF THE SOUTH PACIFIC

Our emissions: -8.11 (0.001 Pg Cyr^{-1})
Total PICT Ocean Sink: -776 (.211 Pg Cyr^{-1})

Our NET emissions: -784 million metric tons CO_2 (0.214 Pg Cyr^{-1})

Worth 4.7 billion dollars on today's Carbon Exchange

- Work at USP on a Carbon Stock Exhange for PICs

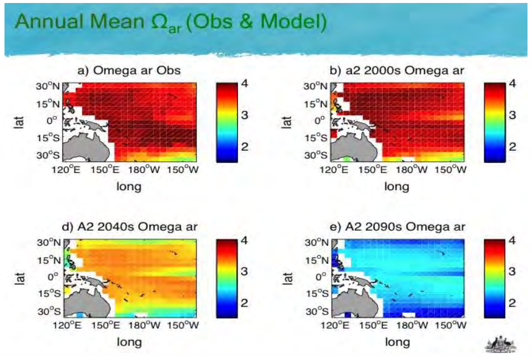
Can we motivate a deeper study of ocean carbon uptake in PICs?

USP THE UNIVERSITY OF THE SOUTH PACIFIC

- Can we get the spatial distribution of ocean carbon uptake correct?
- Can we examine the spatial and depth profiles in of CO_2 uptake including an anthropogenic tracer?
- How does that influence pH and aragonite saturation in the region?
- Could efforts with high resolution models inform us to get the global picture right?

LOCAL CAPACITY IN GLOBAL OA MODELING AT USP

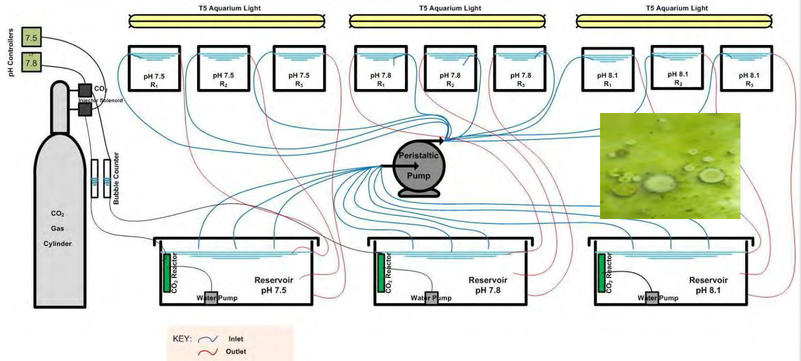
Projected Seasonality in Ocean Acidification in the Western Pacific
MSc Thesis by Sri Durgesh Nandini 2012



Community Climate System Model (CCSM3) ocean carbon model outputs

LABORATORY STUDIES ON OA

Impact of Ocean Acidification on carbonate production by large benthic foraminifera *Marginopora vertebralis* in coastal waters of Fiji . MSc by Roselyn Naidu, 2015

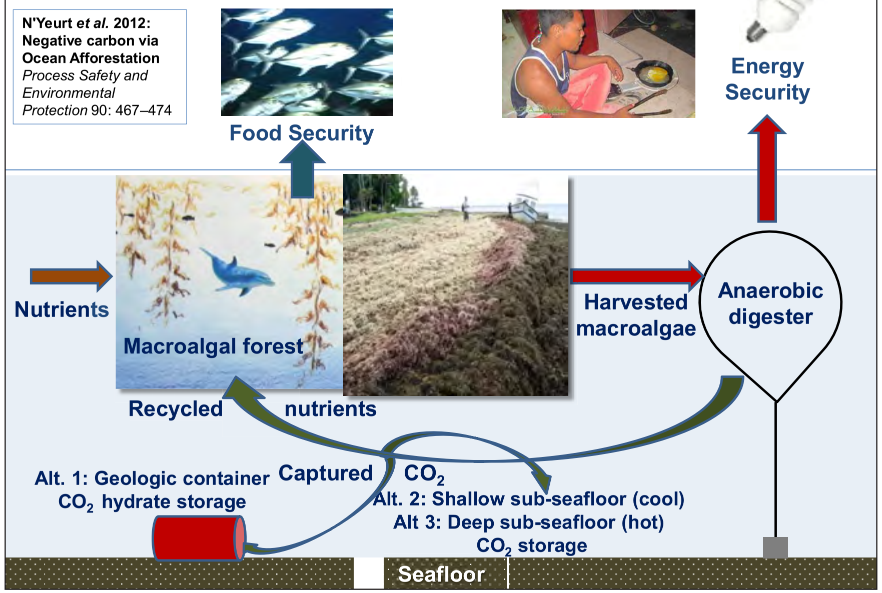


UTILIZING LOCAL CAPACITY FOR OA MODELING

- The large amount of qualified and capable young graduates in the USP Region can form the basis of an Ocean Acidification modelling resource at both the Global and Regional scale. Over 150 postgraduates per year!

OA Mitigation: Ocean Afforestation in PICs

N'Yeurt *et al.* 2012: Negative carbon via Ocean Afforestation *Process Safety and Environmental Protection* 90: 467–474



LOCAL OBSERVATIONS: MONITORING TEMPERATURE

EUROPEAN UNION — USP THE UNIVERSITY OF THE SOUTH PACIFIC

ReefTEMPS Fiji Project at USP

(In collaboration with GOPS/SPC/SOPAC/PCDF)

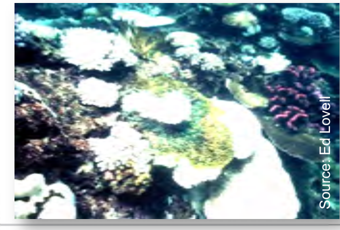
Project coordinators: Dr. Antoine De Ramon N'Yeurt (PaCE-SD), Ms Cherie Whippy-Morris (IMR)

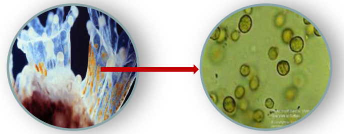
GOPS — USP — SPC Secretariat of the Pacific Community

Why Temperature?

EUROPEAN UNION — USP THE UNIVERSITY OF THE SOUTH PACIFIC

- **Rising seawater temperatures have profound effects on coral reefs of the Pacific Region. Prolonged episodes of warm waters above about 29°C cause corals to bleach**
- **A massive coral bleaching event occured in Fiji in 2000; between 40% to 80 % of corals died (image below). Recovery took about 6 years. Now we have a massive El Niño event underway and likely bleaching in February-March 2016.**
- **Variations in seawater temperature are very critical to the recovery of coral reefs after a bleaching event.**



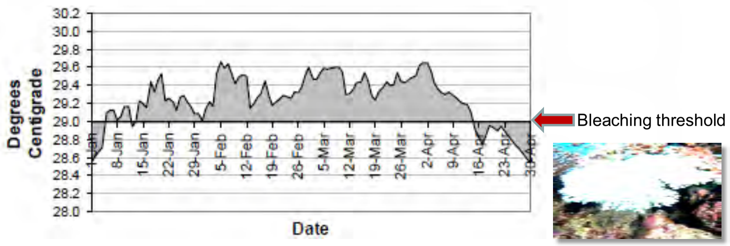


Coral polyps (left) and Zooxanthellae (right)

Bleaching Events

EUROPEAN UNION — USP THE UNIVERSITY OF THE SOUTH PACIFIC

- **Past seawater temperature data for Fiji waters was sourced from a few individuals, and therefore scattered, episodic, of variable precision (Hemco and Hobo loggers) and reliability, and not readily available.**
- **Satellite-based data is available, but only concerns the surface layer (NOAA Beqa virtual Station) and the bleaching threshold does not always correspond to observed field data.** **Precise, continuous *in-situ* data is essential to validate satellite observations and models.**

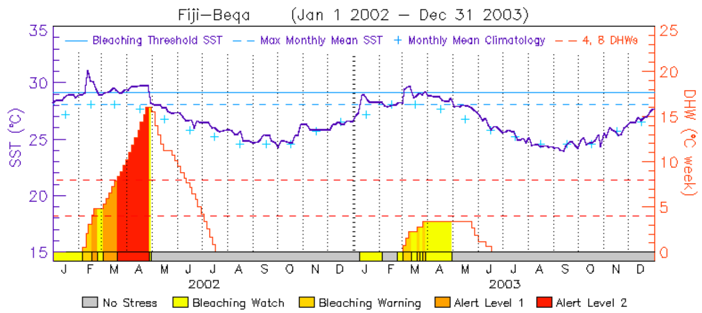


Mean actual observed daily water temperature in the Vatu-i-Ra Passage January to April 2000 (From Sykes & Lovell 2008)

Bleaching Events

EUROPEAN UNION — USP THE UNIVERSITY OF THE SOUTH PACIFIC

Fiji - Beqa Coral Reef Watch Satellite Virtual Station (BEFJ1-NOAA)



*Satellite **Virtual Station** time series graphs of the sea surface temperature (SST) and Coral Bleaching Degree Heating Weeks (DHW) for Beqa Island, Fiji (Courtesy NOAA)*

Observation Platforms in Fiji

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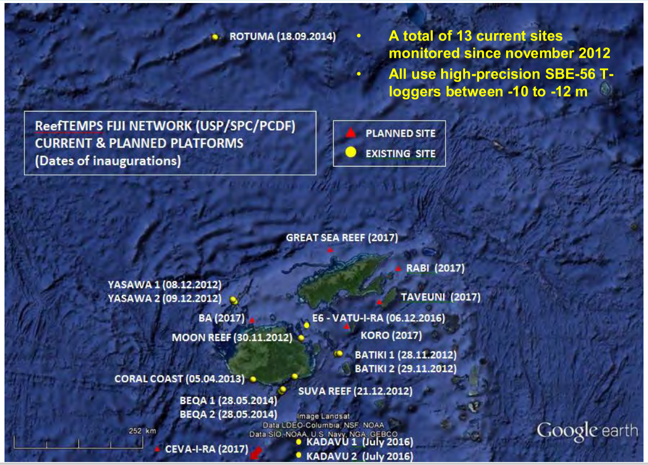

Current and Planned Monitoring Sites

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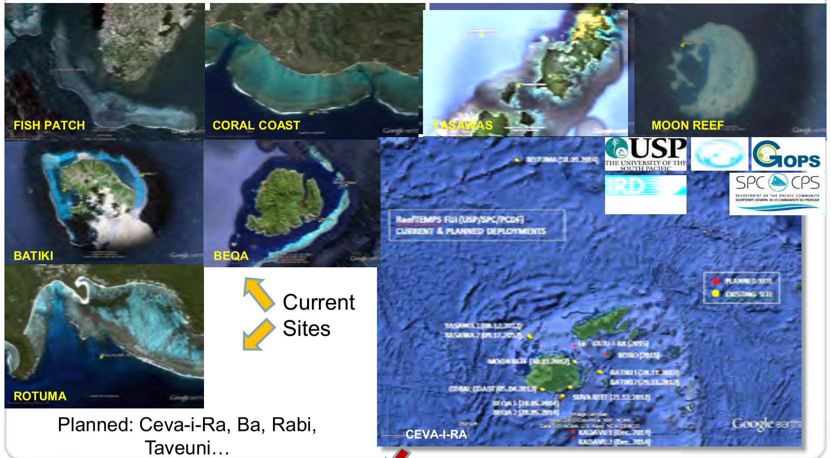

Planned: Ceva-i-Ra, Ba, Rabi, Taveuni…

Typical Site Deployment Profile

EUROPEAN UNION

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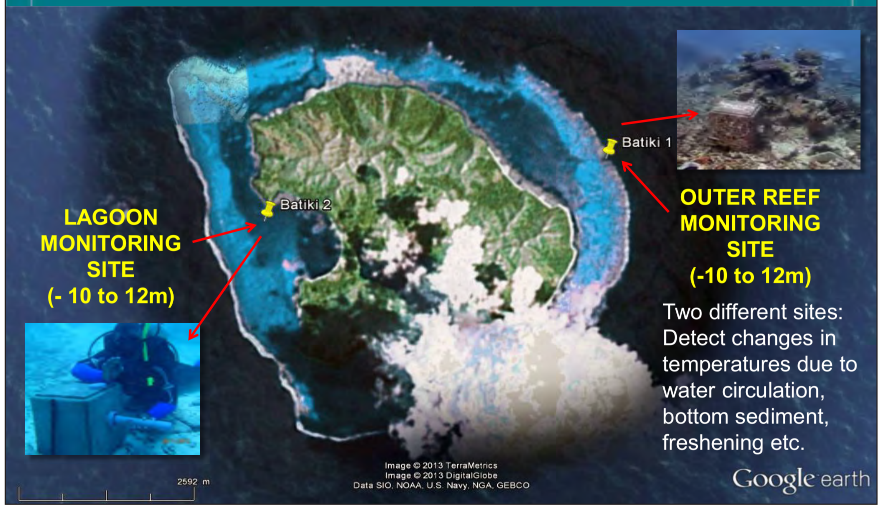

Deployment Logistics

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- USP (with local collaborators) in charge of logger deployment, rotation and data retrieval in Fiji since November 2012.
- Data uploaded and freely accessible on GOPS (DbOceano Database) and USP PaCE-SD data portal. A total of **24** datasets representing over **280 months** of seawater temperature monitoring at 12 sites obtained to date.
- Integration within ReefTEMPS project of GOPS
- Funds obtained from USP Strategic Research Theme for extension of project for one year and addition of 4 more sites in Fiji.
- Also some funds received to extend vertically the monitoring of temperature (VERTEMP project, later slide) at -55, -75 and -90 m (for internal waves and thermocline measurements critical for accurate climate models)

Deplomeent Method

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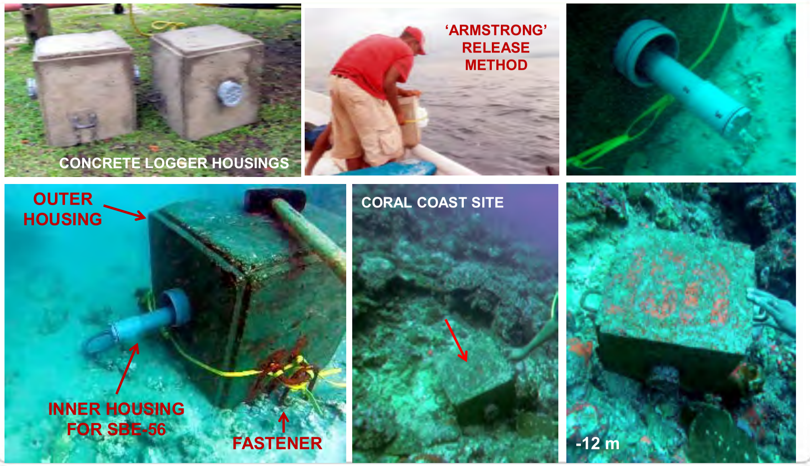

Data Management

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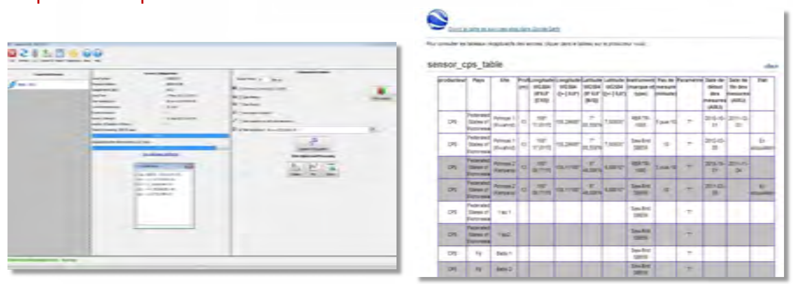
- Data is downloaded by USB connection using SeaTerm® Software every 6 to 12 months
- Data is quality-checked and uploaded to the GOPS website and USP information portals.

http://reeftemps.ird.nc

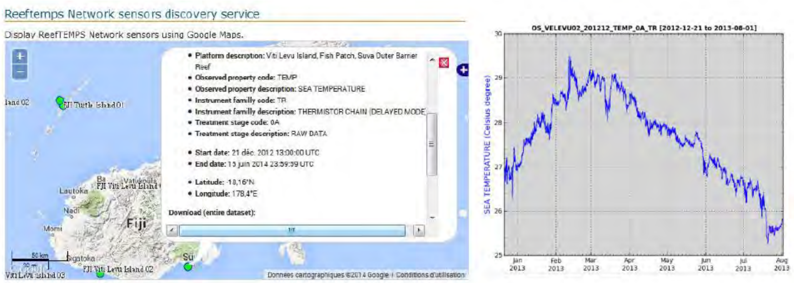


Data Portals

EUROPEAN UNION

USP THE UNIVERSITY OF THE SOUTH PACIFIC

http://reeftemps.ird.nc



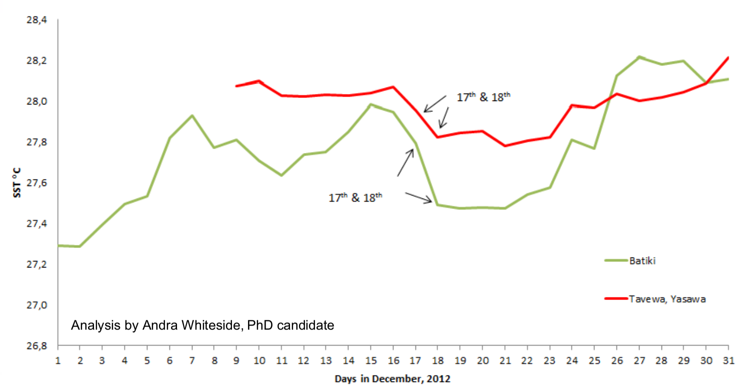
For each site, full datasets are collated and available for download in either RAW (xml), CSV (Excel) or graphical format.
The reefTEMPS datasets are collated and cover entire monitored periods.

SBE-56 Data Analysis for SST Anomalies

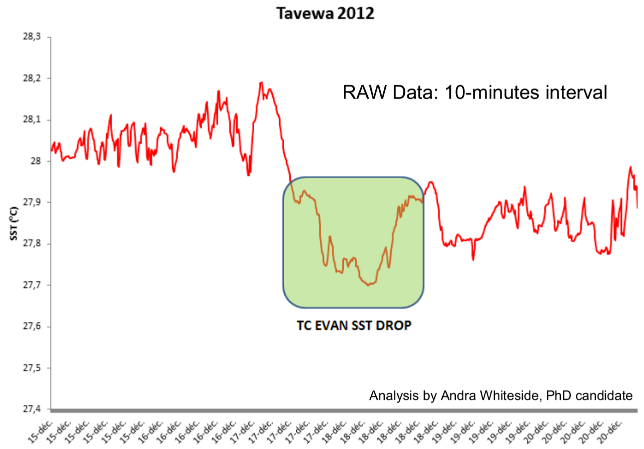
EUROPEAN UNION

USP THE UNIVERSITY OF THE SOUTH PACIFIC

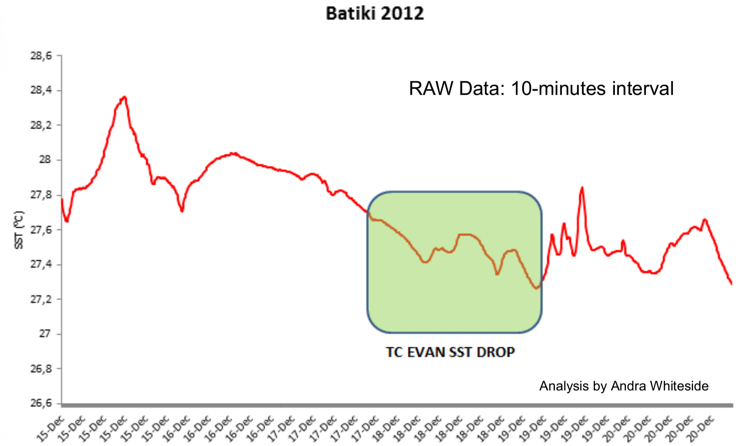
Average Daily SST for December, 2012 at Batiki and Tavewa, Yasawa



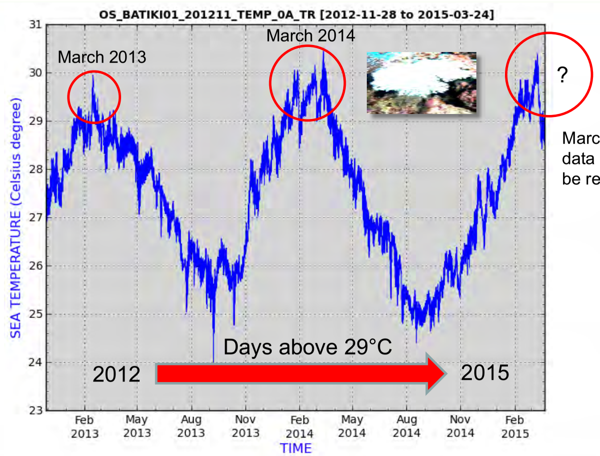
SBE-56 Data Analysis for SST Anomalies



SBE-56 Data Analysis for SST Anomalies



Increase in Days Above 29°C bleaching threshold



March 2015 data still to be retrieved

Ocean Acidification Monitoring in USP Region

- It is essential to have a **long-term monitoring** of OA and related physical parameters in PICs.
- PaCE-SD acquired one SeaFET pH logger and one RBRduo salinity probe.
- Deployed together with water sample validation these two instruments can provide robust pH data at selected ReefTEMP sites in Fiji and the USP region.
- It is anticipated to have joint deployments with SPREP / SPC at strategic sites.
- Need for further capacity building and awareness about OA in PICs.

SeaFET pH autonomous logger (Acquired in 2015)

RBRduo Salinity probe (Acquired in 2015)


EUROPEAN UNION
USP
THE UNIVERSITY OF THE SOUTH PACIFIC
Ocean Acidification and SEAFET Training Workshop
Auckland University, 8-11 September 2015
pH
DIC
pCO2
FIJI


EUROPEAN UNION
USP
THE UNIVERSITY OF THE SOUTH PACIFIC
Thank you for Listening!
Domo arigato!
Maui Bay, Coral Coast, Fiji

Session 3-3

"Studies on the Effects of Warming and Ocean Acidification to Coral Reef Organisms at the Tropical Biosphere Research Center, University of the Ryukyus"

Kazuhiko Sakai
Professor,
Ryukyu University

Professor and Director of Tropical Biosphere Research Center (TBRC), University of the Ryukyus

2014-	Director, TBRC
2010-2013	Director, Sesoko Station, TBRC
2009-	Professor, TBRC
1994-2008	Associate Professor, TBRC

I am a field ecologist of reef corals.
My current research focuses on the effect of global warming and ocean acidification on corals.

THE OCEAN POLICY RESEARCH INSTITUTE

January 20, 2017

Studies on the Effects of Warming and Ocean Acidification to Coral Reef Organisms at Tropical Biosphere Research Center, University of the Ryukyus

Kazuhiko SAKAI

Sesoko Station, Tropical Biosphere Research Center

University of the Ryukyus, Okinawa, Japan

Menu

- About Tropical Biosphere Research Center and Sesoko Station of University of the Ryukyus
- Examples of research at Sesoko Station
  - Thermal stress and coral bleaching
  - Effect of ocean acidification on corals
- International capacity building at Sesoko Station

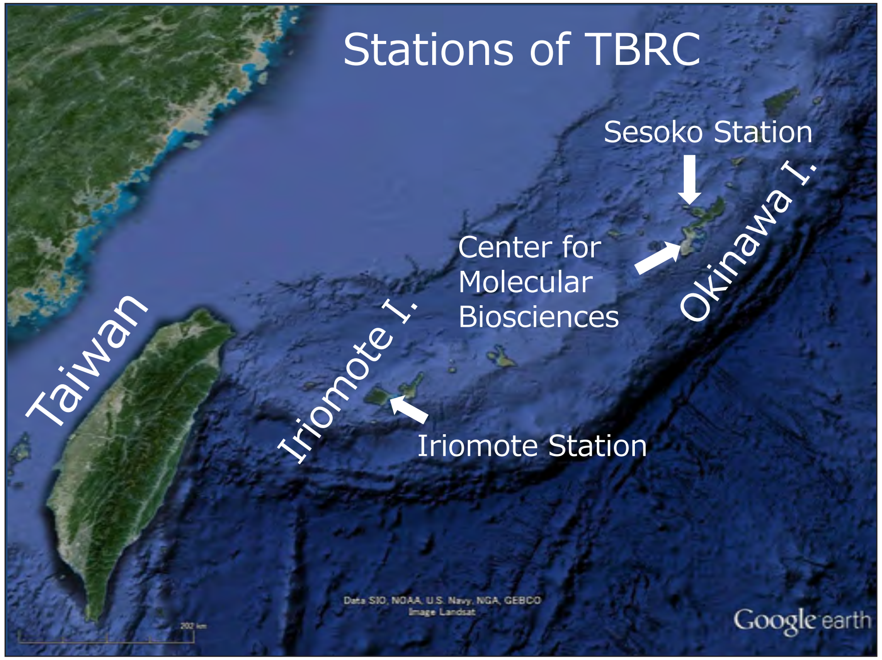
Tropical Biosphere Research Center

- One of the Joint Usage / Research Centers of Japan that are certificated by Ministry of Education, Culture, Sports, Science and Technology, Japan.
- Our mission is to promote collaborative research on ecosystems and biodiversity of coral reefs, mangrove swamps, and subtropical rain forests.

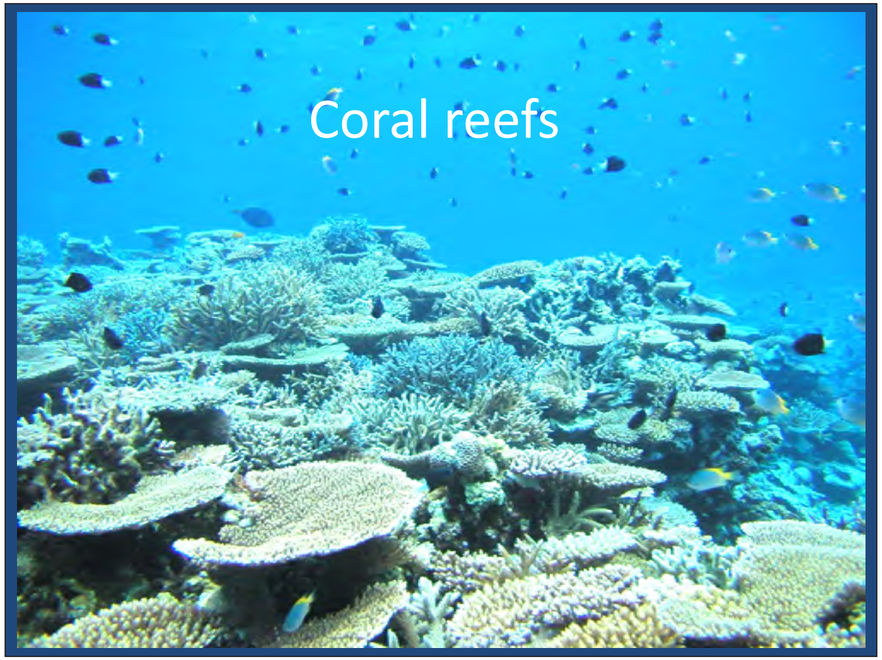
Coral reefs, Mangrove swamps, and subtropical rain forests

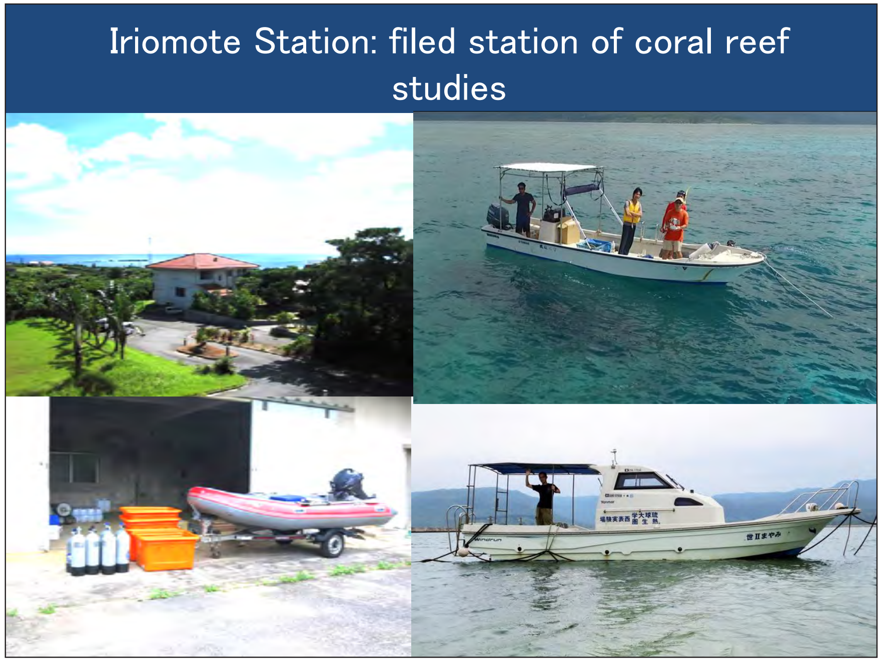
TBRC is only-one Joint Usage / Research Center of Japan which is located in subtropical area

Stations of TBRC




Pristine natural environment

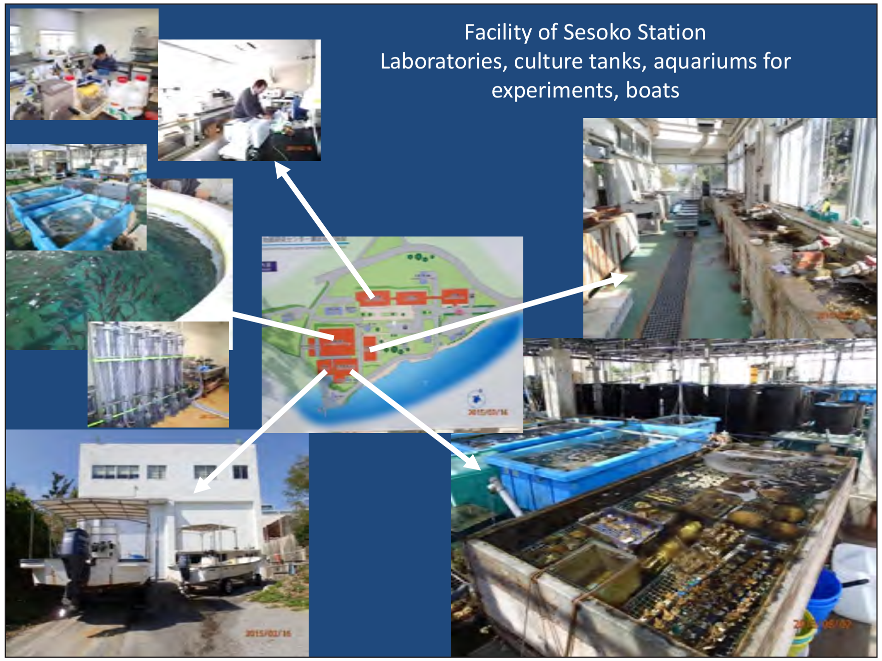

Coral reefs

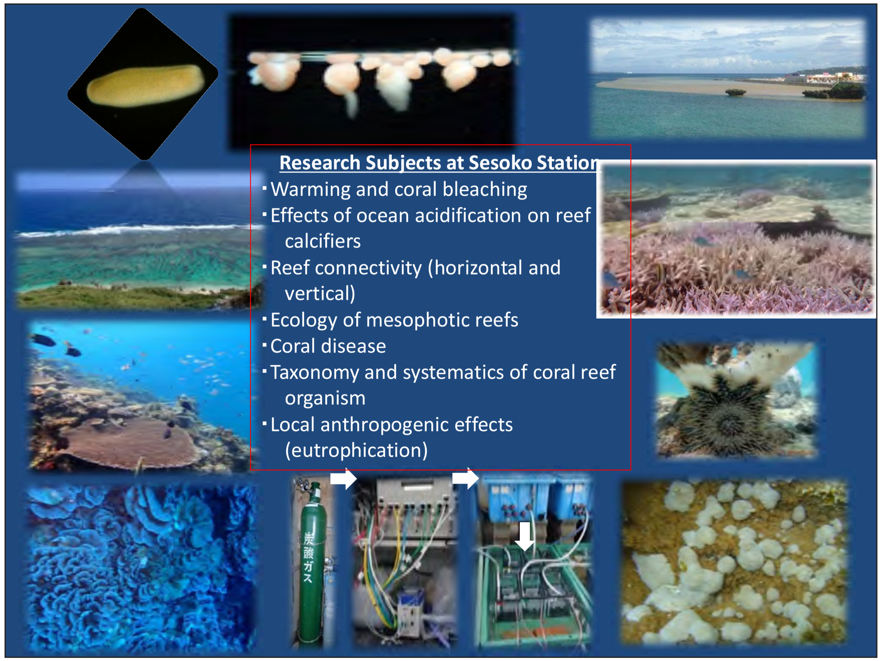

Iriomote Station: filed station of coral reef studies


Sesoko Station
TBRC

Sesoko Station, TBRC

- Mainly studying coral reef organisms and ecosystems
- Domestic and international collaborations
- Field station for coral reef studies
- Aquarium experiments station with running seawater supply
- Dormitory for visitors
- Educational activities in Graduate School of University of the Ryukyus





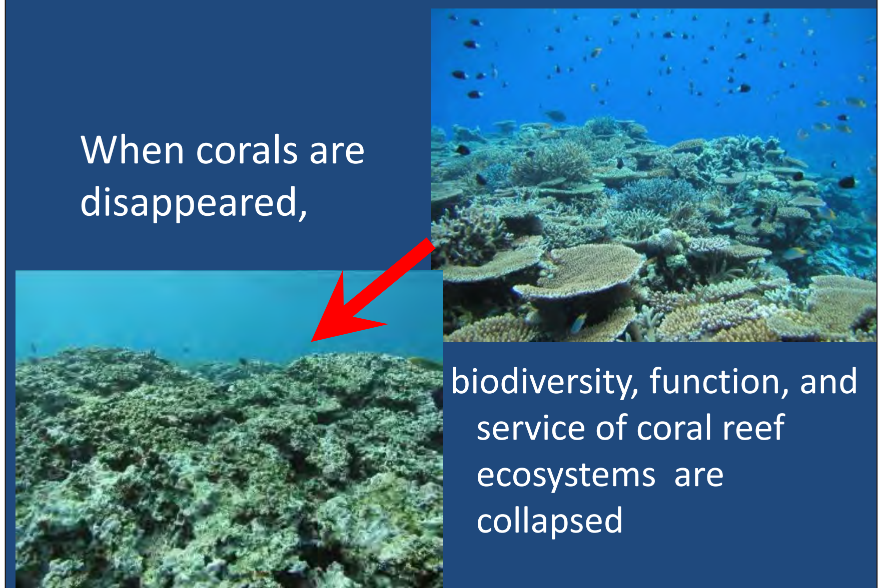
Research examples at Sesoko Station

- Thermal stress and coral bleaching, and the following recovery of coral communities
- Effect of ocean acidification on corals

Reef corals play central role in coral reef ecosystems

- Provision of complex habitats
- Coral-zooxanthella holobionts are main primary producers
- Bacteria in coral cells and skeletons fix nitrogen

When corals are disappeared,



biodiversity, function, and service of coral reef ecosystems are collapsed

Changes in coral community by the1998 thermal stress, in Okinawa Island, southwestern Japan

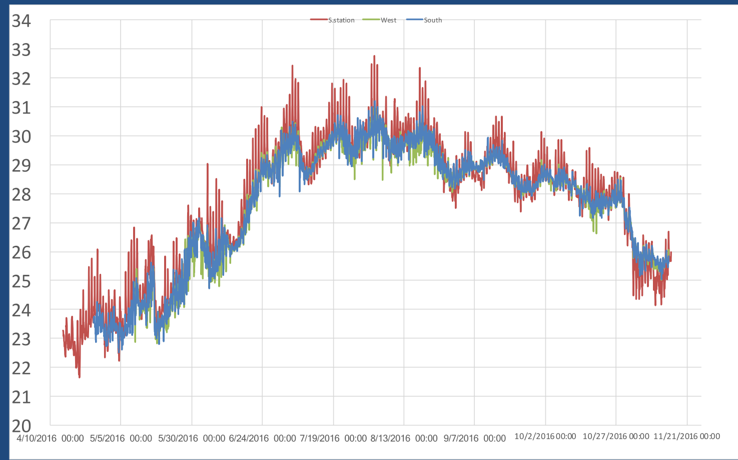
1. Percentage cover of coral community was decreased by 85%
2. Number of coral species was decreased by 61%
3. Winners (massive corals) and Losers (branching corals)

(Loya et al. 2001)

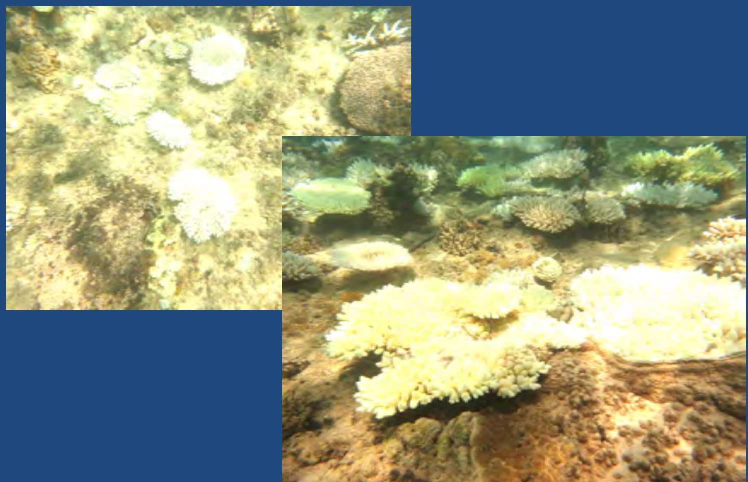
Recovery of coral community was realized by successful recruitment by larvae on Sesoko Station Reef.
Acropora corals were most abundant in recovered communities.

2010

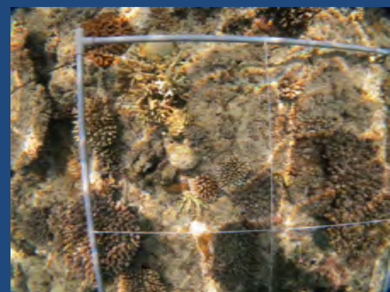
Seawater temperature on Sesoko Station Reef (Red)



Sesoko Station Reef, August 2016



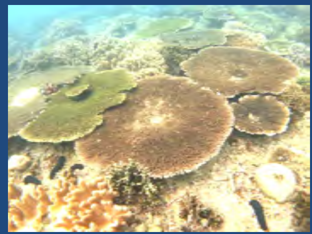
Acropora corals on Sesoko Station Reef in November 2016



Mortality of *Acropora* corals by bleaching in the summer of 2016 was the highest at Sesoko Station Reef around Sesoko Island; Mortality was about 50%.

In contrast, the mortality was less than 5% at other reefs around Sesoko Island, though the mortality was almost 100% in 1998.

West of Sesoko Island in November



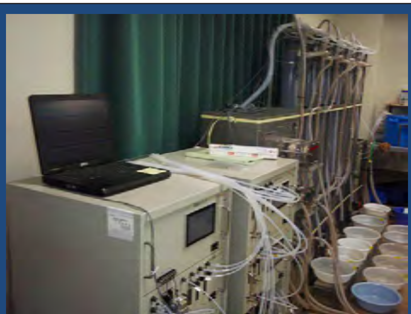
North of Sesoko Island in October

Corals appear to have been improved their thermal stress tolerance around Sesoko I.

Adaptation?

Phenotypic plasticity?

I will challenge this issue after revealing the possibility by diving work to show "hope" for corals in the era of the global climate change.



Indoor AICAL (Acidification Impact on CALcifiers) pCO_2 controlling system at Sesoko Station (developed by Professor Nojiri)

Ocean acidification may less serious to corals than warming

However, ocean acidification may affect corals indirectly by changing biological interactions

International capacity building at Sesoko Station in 2016

Name	Nationality	Affiliation	Research topic
Haryanti, D	Indonesia	Research Associate Professor, UR	Warming and acidification on corals (aquarium)
Passarelli, CA	France	JSPS Postdoctoral Fellow	Biofilms and coral disease (field and aquarium)
Bunda, MVB	Indonesia	PhD candidate, UR	Acidification on corals (aquarium)
Prasetia, R.	Indonesia	PhD candidate, UR	Corals at mesophotic area (field and aquarium)
Stanley, FI	Nigeria	PhD candidate, UR	Sperm motility and fertilization of fish (aquarium)
Singh, T.	Indo	PhD candidate, UR	Coral population dynamics (field)
Manullang, C.	Indonesia	Master candidate, UR	Acidification on corals (aquarium)

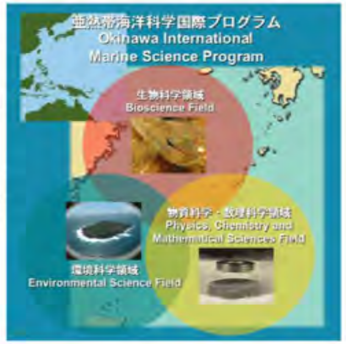
OIMAP

Okinawa International Marine Science Program (OIMAP)
University of the Ryukyus

Welcome to OIMAP !

We are pleased to announce that the Okinawa International Marine Science Program (OIMAP) will receive applicants for the next academic year starting in April 2017.

OIMAP is organized into three fields: 1) Bioscience, 2) Environmental Sciences, and 3) Physics, Chemistry and Mathematical Sciences.



OIMAP is a 9-year program (2007-2015), and during this term we have received many applicants from ~30 countries (see List of applicants by country).

We welcome applications from prospective master's and doctoral

Thank you for your attention

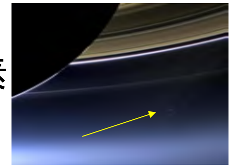
Session 3-4

"Future Earth / SIMSEA and MARINE Crisis Watch & Action"

Toshio Yamagata
Director,
Application Laboratory, JAMSTEC

Toshio Yamagata graduated from the University of Tokyo in 1971.
His professional career includes program director of Frontier Research System for Global Change of JAMSTEC and NASDA (now JAXA), and professor of the University of Tokyo.
After retiring from Dean of School of Science, the University of Tokyo in 2012, he is currently Director of Application Laboratory of JAMSTEC.
He received many honors in physical oceanography and climate dynamics, such as American Geophysical Union fellow, American Meteorological Society (AMS) fellow, Japan Geoscience Union fellow, foreign associate member of l'Academie de Marine of France, the Sverdrup Gold Medal from AMS, the Prince Albert I Medal from the International Association for the Physical Sciences of the Oceans, and the Medal with Purple Ribbon from Government of Japan.

人類生存に不可欠な要素
(necessary elements for human habitability)



In 2013, NASA's Cassini spacecraft captured this image of Earth from Saturn. Seen here, our planet is 898 million miles away (1.44 billion kilometers) and appears as a blue dot at center right.

- 水と生息可能な陸域・大気・海洋環境 (water and habitable environment)
- 衣食住 (food, clothing and shelter)
- 健康 (health)
- 資源・エネルギー (resources, energy)

これらを不安定化する水惑星における変化（人類起源も含む）と変動

Habitability and sustainability are threatened by changes (including anthropogenic ones) and variations occurring in the aqua-planet "Earth". **← Another Sword of Damocles !!**

Sustainable Development Goals

（持続可能な開発目標）

adopted by the UN sustainable development summit
as the post 2015 development agenda

"Future Earth" Program led by ICSU and ISSC in response to Rio+20

国際科学会議と国際社会科学協議会が主導する「未来の地球」計画のコンセプトを単純化すれば

1) to develop the knowledge for responding effectively to the risks and opportunities of global environmental change.

地球環境変化のリスクと好機に効果的に対応する知の強化

2) to support societal transformation towards global sustainability in the coming decades for wellness and well-being of all living creatures.

持続可能な社会への変革を支援

Future Earth （未来の地球）: a 10-year international research program launched in June 2012, at the UN Conference on Sustainable Development (Rio+20) that will provide critical knowledge required for societies to face the challenges posed by global environmental change and to identify opportunities for a transition to global sustainability. It is led by ICSU（国際科学会議）and ISSC (国際社会科学協議会）with UN organizations (UNEP, UNU, UNESCO, WMO) and Belmont Forum.

ICSU RCAP(Regional Committee for Asia and the Pacific)'s Contribution to Future Earth:

SIMSEA

Sustainability Initiative

in the Marginal Seas of South and East Asia

(http://simseaasiapacific.org/)

南及び東アジアの縁辺海における持続可能性イニシャチブ

The idea was born at the 16th Meeting of ICSU RCAP (Regional Committee for Asia and the Pacific), Nov. 26 - 28、2013, Hotel President, Seoul, Korea

Pre-scoping workshop was held at Application Lab, JAMSTEC, Feb. 27-28, 2014, Yokohama, Japan

1st SIMSEA SC at the University of the Philippines, June 30-July 1, 2014

Scoping workshop for prioritization at University of the Philippines, and 2nd SIMSEA SC Nov. 19-20, 2014

3rd SIMSEA SC at the University of the Philippines, Oct. 6-7, 2015

4th SIMSEA SC at the University of the Philippines, Mar. 21-22, 2016

5th SIMSEA SC, Sept. 25, 2016

and SIMSEA Regional Symposium at at Microtel by Windham, Diliman, Quezon City, Sept. 26-28, 2016

From the marine perspective

Dynamic Planet

1.Spatial and temporal scales for assessing sustainability of coastal and marine ecosystems services
2.Extent of cumulative effects of climate change and extreme weather events impacts on marine environments, biodiversity, humans and livelihoods
3.Tipping points and resilience of marginal seas in relation to global change
4.Impacts of priority pollutants on marine organisms and humans
5.Relationships between rapid urbanization and extent of marine pollution effects associated with changing urban and rural landscapes

Sustainable Development

1.Consequences of economic growth strategies on socio-economic and environmental well-being
2.Mechanisms to define balance, trade-offs and cultural bottom lines in resources use
3.Ocean health and its indicators in different regions
4.Establishing ecologically coherent networks of locally managed marine areas including MPAs

Transformations towards Sustainability

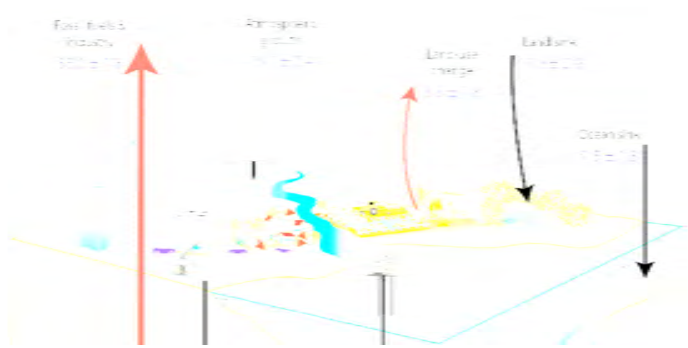
1.Building local community capabilities towards sustainability
2.Co-developing and co-learning plausible alternative pathways toward sustainability
3.Fostering ocean views among resource planners, users and managers
4.Cultural and other determinants of unity and wise use of resources in the marginal seas

In particular,

Importance of recognizing risks due to unsung ocean warming and ocean acidification in Asia and the Pacific

OPRI | THE OCEAN POLICY RESEARCH INSTITUTE

Ocean acidification is directly caused by the increase of carbon dioxide (CO2) levels in the atmosphere. When CO2 enters the ocean it rapidly goes through a series of chemical reactions which increase the acidity of the surface seawater (lowering its pH). The ocean has already removed about 30% of anthropogenic CO2 over the last 250 years, decreasing pH at a rate not seen for around 60 million years. This effect can be considered beneficial since it has slowed the accumulation of CO2 in the atmosphere and the rate of global warming; without this ocean sink, atmospheric CO2 levels would already be greater than 450 ppm.



Source: CDIAC; NOAA-ESRL; Le Quere et al.,2015

Global CO2 budget (2005-2014)

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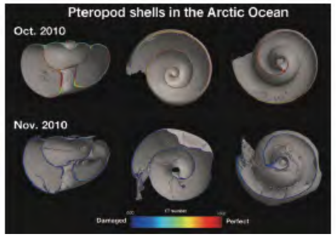
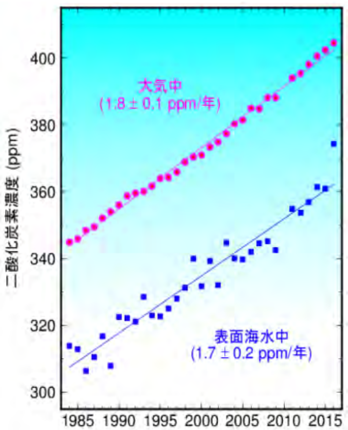
However, the continuation of rapid change to ocean chemistry is likely to be bad news for life in the sea; it will not only cause problems for organisms with calcium carbonate skeletons or shells (such as oysters, mussels, corals and some planktonic species) but could also impact many other organisms, ecosystems.



"Shell degradation of Pteropods in the Arctic" (K.Kimoto, JAMSTEC)

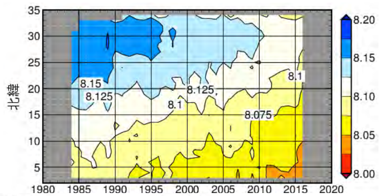
As the IPCC 5th report points out the risks to marine ecosystems, global warming as well as ocean acidification are becoming major subjects that must be addressed. Though actions are being taken in Europe and the US, along with discussions such as CBD and RIO+20, research in Japan is still insufficient due to a lack of understanding by policy–makers and the general public.

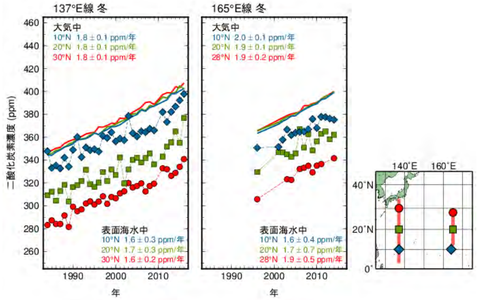
Ocean acidification in open ocean south of Japan



Annual average of CO_2 between 7 and 33° N along 137 ° E

Distribution of yearly surface pH in winter along 137° E





Surface CO2 in winter along 137° E and 165° E

Ocean acidification detected in coastal water around Japan

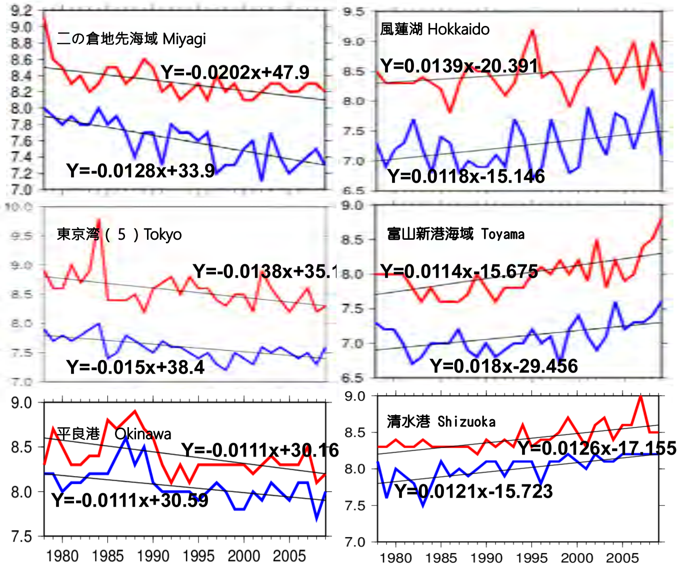
Contributed by
Miho Ishizu*[1], Tomohiko Tsunoda*[2], Yasumasa Miyazawa*[1]
*1 JAMSTEC *2 Sasakawa Peace Foundation

Ocean acidification is observed in open ocean around Japan (Ishii et al. 2011).

In coastal ocean, biogeochemical processes associated with the acidification are more complicated and heterogeneous (Kosugi et al. 2016). For example, the amplitude of seasonal variations of Aragonite Omega exceeds 3 in Tokyo Bay (cf. 0.5 in Ishii et al. 2011).

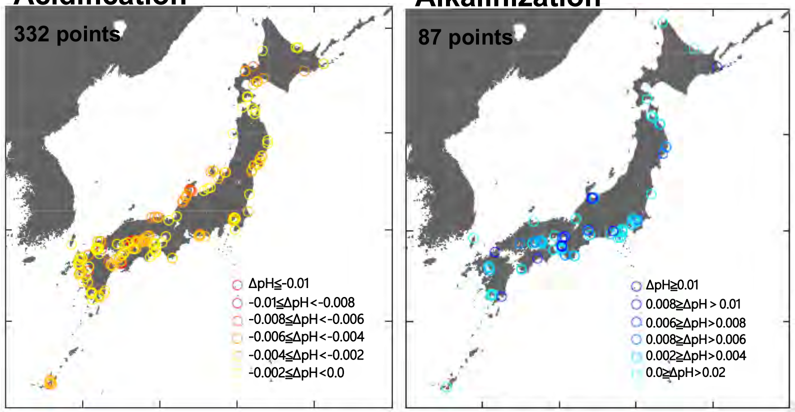
To elucidate the acidification trend/variation in coastal ocean around Japan, multi-decadal PH variations obtained by local prefectures are studied experimentally.

Acidificatin/alkarinization trends in coastal water regions

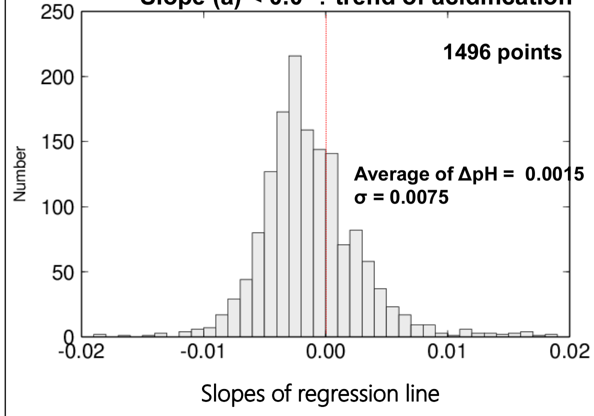


Apparent Acidification/ alkarinization points

Dominance of acidification points despite the complicated trend distribution



Distribution of slopes of linear regression line (y=ax+b)



Decrease of pH = -0.0015±0.0075 yr-1

Comparable trend of the acidification in open oceans

Decrease in pH

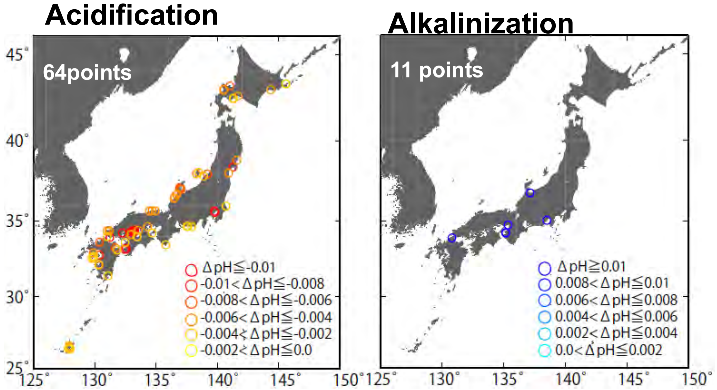
ESTOC : 0.0017±0.0005 yr-1
(mean±1σ)

HOT : 0.0019±0.0005 yr-1

JMA along 135E
0.0018±0.0021 yr-1 in winter
0.0008±0.0019 yr-1 in summe

BATS
0.0017±0.0001 yr-1 in winter

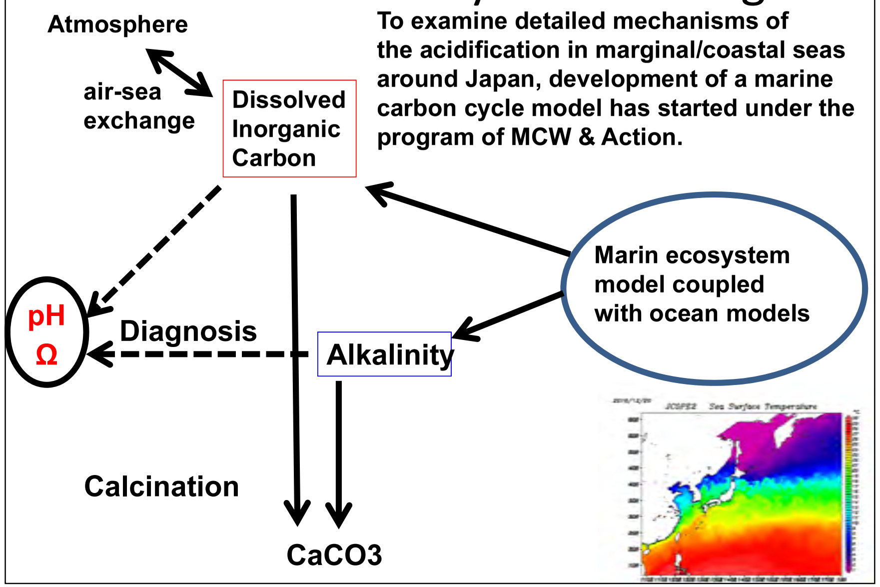
Statistically significant (p>0.05) acidification/alkarinization points



Relatively strong signals of the acidification points?

Marine carbon cycle modeling

To examine detailed mechanisms of the acidification in marginal/coastal seas around Japan, development of a marine carbon cycle model has started under the program of MCW & Action.



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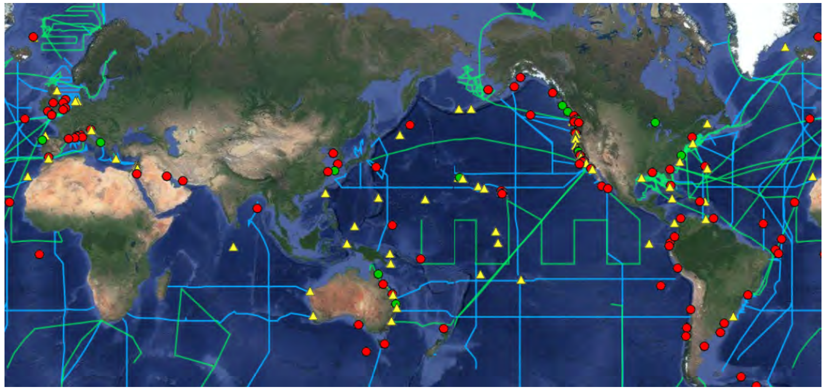
There is a critical need for long-term monitoring of ocean acidification in the Pacific Islands region as current monitoring is insufficient and atoll nations such as Kiribati, Tuvalu and parts of Fiji are under direct threat from sea-level rise and degradation of coral reefs and associated fisheries from climate change and ocean acidification. Accurate and consistent time-series for ocean acidification and other key parameters of the oceanic carbonate system would be crucial for informed climate predictions and decision-making in the region and filling gaps of global ocean acidification monitoring network.



Ocean Acidification(OA) monitoring stations etc.(Source:GOA-ON)

POTENTIAL PROJECT

Regional Monitoring Network Platform on Ocean Acidification

Goal: Obtain precise and quality-comparable ocean acidification (OA) time series for the various sites of the network, which could be directly used for critical climate prediction and modelling studies for the pacific region.

Proposed Steps of Actions:

- ■ Initiate capacity building toward the establishment of Research Laboratory for Climate Science and acquire basic instrumentation for water sample measurements such as a precision Spectrophotometer, pH probes etc.
- ■ Deploy new platforms for OA and temperature measurements in the region to fill a critical need for long-term monitoring of OA as current monitoring is insufficient.
- ■ Disseminate the acquired and quality-controlled data both regionally and internationally through a data portal seamlessly linked to higher-order networks.

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Development of Communication Tools on Ocean Acidification

OPRI-SPF has launched a 5-year program of research to observe and analyze the changing situation. Through this program, we aim to raise awareness regarding ocean risks and develop policy recommendations in order to fill the perception gaps between the serious situation and current levels of understanding.

2015
- •Held international symposium and established the foundations for an information sharing framework

2016
- •Will hold international conference in January 2017 and set up "MARINE Crisis Watch" website

2017
- •Continued promotion of network ties, opening of "MARINE Crisis Watch" website.
- •Submit a policy proposal on the promotion of related policy measures

↓ Strengthening network, hosting workshops

2019
- •Will hold international symposium and submit a policy proposal on specialized countermeasures

Targeting:
- **●Platform for Integration of Scientific Knowledge / Prediction with Data Management Systems**
- **●Public awareness/Capacity Building**
- **●Ocean Policy Making on Global Scale**

Session 3-5　Moderator Speech

Discussion
"Towards Networking in the West Pacific Region"

Yoshihisa Shirayama
Executive Director,
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Dr. Yoshihisa SHIRAYAMA, born in 1955 in Tokyo, Japan, obtained D. Sc. Degree from Graduate School of Science, The University of Tokyo (UT), in 1982.
He then served Assistant and then Associate Professor at Ocean Research Institute, UT. In 1997, he became a professor of Seto Marine Biological Laboratory, Faculty of Science, Kyoto University.
In 2003, the laboratory moved to Field Science Education and Research Center.
He served as Director of the center from 2007. In April 2011, he became Executive Director of Research, Japan Agency for Marine-Earth Science and Technology.
His major research field is marine biology, especially taxonomy and ecology of deep-sea meiobenthos.
He also is working on the marine biodiversity and the impact of ocean acidification upon it.
He was awarded "Okada Prize" from Oceanographic Society of Japan in 1988, Minister of Environment Japan Recognition in 2011.
He also was awarded Cosmos International Prize as a member of Scientific Steering Committee of Census of Marine Life in 2011.

Discussion Topics of Session 3:

1. How to Mainstreaming OA.
   - Ocean Acidification is an obvious threat for marine ecosystem.
   - But it is not a main stream in the debate of CO2 emission reduction, though OA will certainly happen in the future.

2. How to increase public awareness regarding threats of OA.

3. How to monitor OA in western Pacific region.
   - Affordable but accurate enough
   - Public participation
   - Capacity building

4. Mitigation and/or Adaptation against OA
   - Fisheries
   - Aquaculture
   - Eco-tourism
   - Engineering