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The Ocean Decade* started in January 2021!

Mitsuo Uematsu

Emeritus Professor, AORI, the University of Tokyo

Member of the Executive Planning Group of the Ocean Decade

The *Ocean Decade* commenced in January 2021, and its vision is to achieve “the science we need for the ocean we want.” To this end, a wide range of partners will implement endorsed actions in the form of programs, projects, and activities over the next decade. Proponents of these decade actions will have the opportunity to join a highly visible, shared global effort that will build upon decades of achievements in ocean science. There will be opportunities to create new collaborations across disciplines, continents, and generations, as well as an increased access to new sources of support.

Seven outcomes will define the ‘ocean we want’ at the end of the Ocean Decade: (1) a *clean* ocean, (2) a *healthy and resilient* ocean, (3) a *productive* ocean, (4) a *predicted* ocean, (5) a *safe* ocean, (6) an *accessible* ocean, and (7) an *inspiring and engaging* ocean (the latter of which has been added to the six previous goals of the implementation plan version 2.0 proposed in August 2020). The recently added seventh outcome is where society understands and values the ocean’s relationship with humanity’s well-being and sustainable development.

The mission of the Ocean Decade is “to catalyze transformative ocean science solutions for sustainable development, connecting people and our ocean.” The Ocean Decade objectives form the second tier of the framework, and guide the multi-step, iterative, and cyclical processes that are required to fulfill the Ocean Decade Challenges. The objectives involve three non-linear, overlapping steps: (i) the identification of ocean knowledge that is required for sustainable development; (ii) the generation of data, information, and knowledge for the development of a comprehensive understanding of the ocean, its components, and its interactions; and (iii) the use of the generated knowledge and understanding of the ocean to deploy solutions for sustainable development.

The Ocean Decade Challenges in Figure X form the highest level of this framework, and represent the most immediate and pressing priorities for the Ocean Decade. They aim to unite decade partners in collective action at the global, regional, national, and local scales, and will contribute to the



Figure X. Ocean Decade Challenges from the implementation plan summary (2020) <https://oceandecade.org/resource/109/> Summary---Version-20-of-the-Ocean-Decade-Implementation-Plan

achievement of the Ocean Decade outcomes; thus shaping the overall contribution to the 2030 Agenda and other policy frameworks.

The initial call for Decade Actions was the first in a series that will be launched as part of the Ocean Decade, and it focuses specifically on large-scale, international, transformative programs, as well as large-scale contributions of in-kind or financial resources for Decade Actions or coordination costs. Decisions on endorsement under this call will be made in the first quarter of 2021.

Endorsed programs will be introduced during the First International Conference of the United Nations Decade of Ocean Science for Sustainable Development at Estrel Congress Center, Berlin, Germany, from May 31 to June 2, 2021.

*United Nations Decade of Ocean Science for Sustainable Development (2021-2030)

Recent activities related to the Intergovernmental Oceanographic Commission (IOC)

Yutaka Michida

Professor, Center for International Collaboration

The 53rd Session of the Executive Council of the Intergovernmental Oceanographic Commission (IOC), originally scheduled for June 2020, was postponed until the first quarter of 2021, similarly to many other international conferences, meetings, and symposia because of the global COVID-19 pandemic. Last year was, however, the 60th anniversary of the IOC since it was established as a subsidiary body with functional autonomy within UNESCO in 1960. A celebration event for the anniversary was organized online on December 14, 2020 (Figure 1), where the opening congratulatory speech of the event was delivered by H. E. Ms. Audrey Azouley, Director-General of UNESCO. This was followed by a series of speeches from successive officers of the IOC, including the present IOC Chairperson, Capt. Ariel Troisi. The latest publication of the IOC, the Global Ocean Science Report 2020 (GOSR-2), was launched during the event and made available online both its full version, and executive summaries in six UN languages: English, French, Spanish, Russian, Arabic, and Chinese (Figure 2; <https://en.unesco.org/gosr>). Professor Yutaka Michida, director of the Center for International Collaboration (CIC) of Atmosphere and Ocean Research Institute (AORI), is one of the leading authors of this publication and responsible for the chapter entitled “Data and information for a sustainably used ocean.”



Figure 1. Opening slide of the online event for the 60th anniversary of IOC held on Dec. 14, 2020.

The UN's Decade of Ocean Science for Sustainable Development (2021-2030) commenced Jan. 1, 2021. The IOC has been leading its preparatory phase based on the Resolution (72/73) at the 2017 UN General Assembly (UNGA), and submitted the Implementation Plan of the Decade to the UNGA in 2020 for adoption. All faculty members of the CIC are actively contributing to Japan's national planning and implementation of the Decade by playing leading roles in the establishment of a Japanese national committee for the Decade in consultation with related ministries of the Japanese government. The Japan Society of Ocean Policy (JSOP) and Sasakawa Peace Foundation jointly established an interdisciplinary discussion forum on the Decade in August 2020, and have organized a series of meetings since then. In December 2020, Prof. Michida was elected as one of the Vice Presidents of JSOP, and Prof. Mitsutaku Makino of the CIC was appointed as the Chairperson of the Academic Committee of JSOP who presides over the discussion forum. The CIC has maintained a high level of contribution to the national implementation of the Decade throughout the forum.



Figure 2. Global Ocean Science Report 2020, published online, December 2020.

International Expert Workshop on Marine Plastic Litter Monitoring and Data Sharing

Yutaka Michida

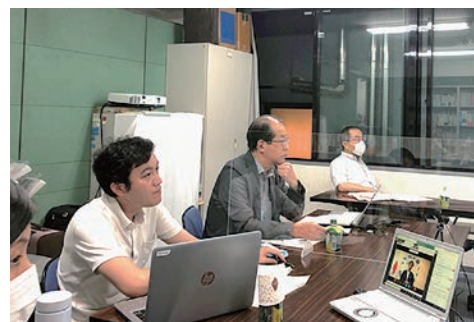
Professor, Center for International Collaboration

Professor Yutaka Michida, director of the Center for International Collaboration (CIC) of AORI, has chaired two international expert workshops on marine plastic litter, both organized by the Ministry of Environment of Japan. The “G20 workshop on harmonized monitoring and data compilation of marine plastic litter”, and the “International preparatory meeting on marine plastic litter monitoring data sharing project”, were held online on September 7 and December 17, 2020, respectively. Both workshops aimed at developing a global database of microplastic distributions on the sea surface.

Marine pollution caused by increasing plastic litter in the ocean has been recognized as one of the most serious environmental issues among international political leaders, particularly since the 2015 G7 Summit in Schloss Elmau, Germany where it was presented as one of the essential agenda items. The Japanese government has taken a leading role in the harmonization of methodology of marine microplastic monitoring based on the agreements achieved at the summit, and have since organized an annual series of international expert workshops with active participation of international experts in this field. One of the outcomes from this initiative, a publication entitled “Guidelines for Harmonizing Ocean Surface Microplastic Monitoring Methods”, was released in 2019 and is available on the website of the Ministry of Environment of Japan, as well as the Ocean Best Practices site of the IOC/UNESCO. As the Chair of the series of international workshops, Prof. Michida has been deeply involved in these activities.

The first Workshop in September 2020 was hosted by the Ministry of Environment of Japan (MOEJ), and supported by the Ministry of Environment, Water & Agriculture of the Kingdom of Saudi Arabia as G20 Presidency in 2020 G20 summit. The G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth in 2019, and its follow-up meeting on the implementation framework held in October of the same year, called for the promotion of harmonized monitoring methods and data compilation. This workshop was implemented in successive steps to discuss and share the importance of globally harmonized monitoring methods and compiled monitoring data, as well as to promote a worldwide network for harmonization and data sharing of marine plastic litter measurements. Experts from related international organizations, programmes, and projects, including the UN Environment Programme (UNEP), International Oceanographic Data and Information Exchange (IODE), and the Group of Experts on Scientific Aspects of Marine environmental Protection (GESAMP), were invited to give presentations. They emphasized the importance of the harmonization of monitoring methodology and international data sharing, and suggested that the FAIR principle (findable, accessible, interoperable, and reusable) should be applied in the development of any data sharing mechanism (Photo 1).

The second workshop was held to solidify more practical discussions towards the development of a global database for marine microplastics on the sea surface. Invited experts, including Prof. Hiroaki Saito of the CIC, actively discussed the concept and structural design of the database based on the materials presented by the Secretary of Japan for this workshop. Additionally, a prototype data system under construction was introduced. Discussions included a wide range of aspects, encompassing not only technical points such as the implementation of GIS (geographical information systems) to further the objectives, but also political matters including acceptable data policy to most data and information contributors. The workshop identified pertinent items from both the technical and political realms for further discussion in the next international expert workshop, to be held online in February 2021 (Photo 2).



Prof. Michida (center), Chair of the opening session of the online G20 Expert Workshop, listens to the opening address given by Mr. Shinjiro Koizumi, the Minister of Environment of Japan on September 7, 2020.



Prof. Michida chairs the second online Workshop on December 17, 2020.

Overview of PICES–2020 Virtual Annual Meeting

Mitsutaku Makino
Professor, Center for International Collaboration

This past year, the PICES Annual Meeting was organized online for the first time in its history. The overall theme was, “How does 30 years of research on changing North Pacific ecosystems inform the UN Decade of Ocean Science for Sustainable Development Goals (SDGs)?”. Under this theme, a total of 60 web meetings were organized between September 1 and November 4, including three workshops and four sessions. Taking into account the time differences amongst the Member Countries, the meetings lasted from 2 to 3 hrs per day, starting from approximately 4 or 5 pm in Pacific Standard Time (i.e., in the morning of the following day in Japan). There were 502 participants from 17 countries (https://pices.int/meetings/annual/PICES-2020/PICES_2020_reg_summary.aspx). According to the Secretary’s estimate, 768.85 metric tons of CO₂ emissions, equivalent to the combustion of 1780 barrels of oil, were saved by holding a virtual meeting, .



Composite image of Professor Saito used at the Virtual Wooster Award receiving ceremony.

The meeting’s opening ceremony was organized on October 26, 2020. In the ceremony, Professor Hiroaki Saito of the CIC received the PICES Wooster Award (<https://meetings.pices.int/awards/Wooster-Award>). The Wooster Award is named in honor of Professor Warren S. Wooster, a world-renowned researcher and statesman in the area of climate variability and fisheries production, as well as a principal founder and the first Chairman of PICES. The award is given annually to an individual who has made significant scientific contributions to Northern Pacific marine science, such as understanding and predicting the role of human-climate interactions on marine ecosystem production. Professor Saito is the fourth recipient of this award from Japan, and the second from The University of Tokyo after Professor Yutaka Nagata in 2002.

A secondary important topic in the meeting was the UN Decade of Ocean Science for Sustainable Development (UNDOS), which commenced in January 2021 (<https://www.oceandecade.org/>). In pursuit of this, several new groups were established in the conference, such as the Study Group on United Nations Decade of Ocean Science for Sustainable Development (SG-UNDOS), the Study Group on Early Career Ocean Professionals (SG-ECOP), and the Study Group on Science Communications (SG-SciCom). UNDOS is an unequivocal opportunity to promote the international collaboration of marine science, where both PICES and ICES are expected to play the principal roles in this initiative.

Scientific collaboration with Asian countries

Hiroaki Saito
Professor, Center for International Collaboration

The waters from Japan to the Coral Triangle are a sea of fertility. Fisheries and various ecosystem services support the societies and create unique cultures in this region; however, increasing human populations and anthropogenic activities are degrading the marine ecosystem. For the sustainable development of this region, scientists are requested to prepare the best scientific knowledge on conservation of ecosystems and marine spatial planning in a timely manner. Since marine ecosystems are interconnected, and the majority of areas lie within the area of national jurisdiction, international collaboration is essential to appropriately respond to the request. To promote international scientific and educational activities in the region, the CIC held the International Workshop on the Emergent Issues of Marine Ecosystems in Southeast Asia: For Sustainable Use of Marine Ecosystem Services in 2019. The attendees recommended the development of an international project for the sustainable use of marine ecosystems. After the

workshop, scientists proposed a new international project to Japan Society for the Promotion of Science (JSPS), the Collaborative Research and Education Project in Southeast Asia for Sustainable use of Marine Ecosystems (CREPSUM). The goals of the project are to: 1) establish an international science and educational network for the Southeast Asian marine ecosystem, 2) progress marine ecosystem studies on emergent issues for conservation and sustainable use of marine ecosystem services in Southeast Asia, and 3) contribute to the UN Decade of Ocean Sciences and UN SDG 14 “Life below water” by compiling the best scientific knowledge. The proposal was accepted as a three-year project CREPSUM commenced in April 2020. Unfortunately, all planned international joint activities in 2020 were canceled because of the COVID-19 pandemic. Thus, this unexpected vacant time was used to summarize past results of joint activities, and create field guides for the identification of fish and jellyfish in Malaysian waters that will be published by March 2021. We are looking forward to the relaxation of the present COVID-19 restrictions and resuming joint scientific and educational activities under CREPSUM. Please visit the website for more details (<https://jspscrepsum.wixsite.com/mysite>).

Strategic partnership activities during 2020 with the Australian National University

Yusuke Yokoyama

Professor

Analytical Center for Environmental Science: ACES

Another year of active exchanges of students and staff between the Atmosphere and Ocean Research Institute (AORI) and the Australian National University (ANU) was planned for 2020; however, because of the unprecedented COVID-19 pandemic, many mobilizations have been restricted, including the planned R/V Falkor research expeditions in the Great Barrier Reef funded by the Schmidt Ocean Institute. Although originally planned research activities were largely restricted, the cruise was still conducted under a modified schedule and sampling sites, Australian researchers’ participation, together with the Schmidt Ocean Institute’s skilled technical staff, made the cruise a scientific success. Numerous further studies on the reef environment will be conducted in the coming years.

The Research School of Physics at the ANU has offered an Honorary Professorship to Prof. Yusuke Yokoyama, with the expectation of more frequent staff exchanges between the institutions. One of the primary topics of collaborative interest was studying the Anthropocene using various geological and oceanographic archives from the environment to measure trace nuclide abundance by accelerator mass spectrometry (AMS). The AMS at AORI cannot measure the heavier isotopes that are used to identify anthropogenic activity, whereas this is possible at ANU. Students and staff planned to stay at ANU for more than two weeks; however, the travel bans because of the pandemic affected this activity. Despite these challenges, timely virtual communication allowed us to measure the first set of samples before the end of the year, and we are planning to publish these results that will be used to help define the Anthropocene epoch.

ANU is one of the main hubs of the Australian Center for Excellence in Antarctic Science (ACEAS), and Prof. Yokoyama is participating in this project with an aim to host students and young scientists who conduct Antarctic research. Thus, AORI will also act as an international contributor for this large project.

Schools were scheduled to reopen in September, but have been forced to abandon this plan for safety concerns. However, both the ANU and AORI, together with the GGG (Go Global Gateway office) staff members, reached an agreement to hold a joint, weeklong course online. It is planned to commence mid-February 2021, and various activities have been planned, including lectures, workshops, groupwork, etc. Professors at the Kashiwa Campus and the International Coastal Research Center (ICRC) of AORI will help run the course, and although more than 60 students have expressed an interest in participating.

Report on the 2020 Virtual CFMIP Meeting

Masahiro Watanabe
Professor
Climate System Research Division



During September 14–17, 2020, an international conference named *The 2020 Virtual CFMIP Meeting on Clouds, Precipitation, Circulation, and Climate Sensitivity* was jointly hosted online by the Cloud Feedback Model Intercomparison Project (CFMIP), and the National Center for Atmospheric Research (NCAR), CO, USA. CFMIP is an active research community that contributed to the Coupled Model Intercomparison Project (CMIP), which manages global climate simulations used for assessments in the IPCC Reports. The history of CFMIP goes back to more than a decade, in which I have served as a co-chair since 2017. It was launched by several climate modeling centers to compare simulations of the effects of cloud feedback on global warming. Over recent years, research foci of CFMIP have expanded to understand clouds, precipitation, and circulation changes in response to radiative forcing, such as increasing greenhouse gases, with a greater emphasis on using the satellite observations.

CFMIP has organized annual meetings in cities around the world, and tentatively planned to hold the 2020 meeting in Seattle, WA, USA. Due to a coronavirus pandemic, the physical meeting was replaced by a virtual one (see photo below). We had over 150 participants from various continents, and additional viewers watched the YouTube stream of the meeting. Because of the limited time for daily sessions, the meeting was reprogramed to consist only of a few invited talks, but participants were encouraged to submit their poster virtually for everyone to explore during the meeting and foster discussion.

The organizing committee focused on three key questions in climate science relevant to the CFMIP's focus for the day: 1) Does convective organization matter for climate? 2) Does atmosphere-ocean coupling matter for climate? 3) Do extratropical cloud feedbacks matter for climate? The speakers were invited to make presentations that included a review of the past advances in our understanding of each question, an introduction of more recent research results, and a wrap-up with future perspectives. Discussions on each topic were available on *Slido* throughout the sessions, and continued at separate local hubs hosted by individuals. Overall, the meeting was a success, and participants, especially early career scientists, gave very positive feedback to the organizers. However, online meetings do not provide opportunities for the participants to casually chat with each other and socialize while in a foreign country (most would acknowledge that it is an essential part of attending international conferences). Thus, we hope that we can meet in person in Seattle as planned for September 2021.



Visiting Professors

Name / Affiliation	Nationality	Length of stay	Subject for study
LEICHTER, James Scripps Inst. of Oceanography University of California, San Diego Professor	USA	2019/9/29-12/26	A Japan-U.S. collaborative study on the environmental and community dynamics in coastal marine ecosystems
LEAT, Philip T. University of Leicester / British Antarctic Survey Honorary Research Fellow	United Kingdom	2019/11/16-2020/3/15	Marine geological study of the South Sandwich Arc
MILNE, Glenn Anthony University of Ottawa, Canada Professor	United Kingdom	2019/10/1-11/9	The influence of 3D Earth structure on interpreting sea-level observations for past ice sheet evolution
STURCHIO, Neil C. Department of Geological Sciences, University of Delaware Professor and Chair	USA	2019/6/9- 7/8	Isotopic studies of samples from terrestrial and marine environments to explore geochemical tracer applications for understanding mineral-water interactions and reactive transport in environmental systems.
DO, Hyung Ki 都亨基 Handong Global University Professor	Korea	2019/12/7-2020/2/23	Studies on the production of puffer fish toxins by marine bacteria
HIRST, Andrew University of Liverpool Professor of Ecology	United Kingdom	2019/8/1-2020/3/31	Zooplankton ecology, physiology and role in food webs: testing and developing major theories using marine organisms

Visiting Professors' report

LEAT, Philip T.

*British Antarctic Survey, Cambridge, UK
Honorary Research Fellow*

It was a delight to visit AORI for four months from November 2019 until March 2020. The length of the visit gave me time to take part in a range of joint field and laboratory work with colleagues in Japan. During the visit, I collaborated with Professor Asuka Yamaguchi of AORI's Department of Ocean Floor Geoscience and also Dr Kenichiro Tani of the



Department of Geology and Paleontology of the National Museum of Nature and Science (NMNS) at Tsukuba.

The purpose of my visit was to work on a project investigating the tectonic evolution of the Scotia Sea, a scientifically critical region where the South Atlantic meets Antarctica. The region largely consists of continental crustal blocks that originated at the junction of South America and Antarctica, neighbours in the Palaeozoic to Early Mesozoic supercontinent Gondwana. During the later stages of Gondwana break-up, the blocks formed a land bridge joining South America with Antarctica and Australia. As they rifted further apart, the region developed into the present Drake Passage, the most important ocean gateway between the Pacific and Atlantic oceans. However, the structure of these continental blocks and their tectonic movements are largely unknown. The South Orkney Islands, a rare emergent locality on one of the larger blocks, consist of metamorphic rocks that are part of an accreted subduction complex, but the offshore extent of the subduction complex is unknown, and other blocks are entirely submerged and unsampled. Shuffling of the crustal blocks by strike-slip movements during extension of the Scotia Sea adds to the complexity. Nevertheless, because of its key gateway role, understanding the Drake Passage is very important in models of southern hemisphere biodiversity, global ocean current development and lithospheric break-up models of Gondwana.

During my visit, I worked on sampling and investigating several of the key crustal blocks in the southern Scotia Sea around the South Orkney Islands. In order to obtain samples, I joined Prof. Yamaguchi and Dr Tani on a cruise of the research ship Hakuho Maru. The KH-19-6 cruise formed the fourth leg of the 30th Anniversary around-the-World scientific cruise of the Hakuho Maru, starting in Punta Arenas, Chile in December 2109 in and ending in Cape Town in January 2020.

During the cruise, we sampled rocks from several of the crustal blocks in the southern Scotia Sea, including schists and sandstones of the South Orkney subduction complex and related igneous rocks. Understanding the distribution of the subduction complex, which originated on the Pacific margin, among the crustal blocks of the Scotia Sea will enable reconstruction of the distribution of the crustal blocks relative to the margin. Dating of the igneous rocks and the provenance of the sandstones will provide further key data for reviewing models for Scotia Sea Cenozoic evolution. It was a privilege for me to join the cruise, which was a highlight of my visit, and it was exciting to be a part of the shipboard Japanese team. The results of the cruise were excellent, and being on the ship gave me an opportunity to interact with Japanese students and other researchers very closely. Prof. Yamaguchi, Dr Ken Tani and staff and students at AORI and at NMNS were exceedingly welcoming to me at all times during my stay. As part of my interaction, I gave a seminar at AORI on 'The Scotia Sea: a key global gateway' to staff and students at AORI and a similar presentation while on the Hakuho Maru. I was also able to use laboratories at NMNS to start U-Pb dating of zircon grains for rocks sampled by dredging during the cruise, and also used the SEM and XRF analysis facilities there.

Toward the end of my stay, I took part on a fieldtrip to the Kanto Mountains with Prof. Asuka Yamaguchi. This was an excellent opportunity to examine global type examples of accretionary complexes associated with Jurassic and Cretaceous subduction beneath Japan. (The pictures were taken during examination of schists of the Sanbagawa metamorphic complex along the Arakawa river). These complexes are similar in both lithology and age to accretionary complexes of the Pacific margin of West Antarctica, including the one exposed in the South Orkney Islands that we investigated during the cruise.

Do Hyung Ki

*School of Life Science, Handong Global University
Professor*

Fantastic visiting in AORI

I work and teach as a professor in School of Life Science, Handong Global University in Korea. I am interested in the detection of useful marine microorganisms and useful lactic acid bacteria (LAB) in Korean fermented foods.

I have been visited Japan many times so far, but first time in AORI. I have been stayed from December

7, 2019 to February 23, 2020 at Kashiwa Campus of the University of Tokyo this time.

I had been studied in ORI (former AORI) during 1986~1990 as a Ph.D candidate student. I acquired Ph.D in March 29, 1990. The title was named as 'Tetrodotoxin-producing bacteria and the mechanisms of toxin



Do Hyung Ki visiting professor (left) with Hamasaki Koji host professor

accumulation in marine environments'. And I visited ORI again with my family from February of 2004 to January of 2005 as a Sabbatical year. I researched on the clarification of marine pollution using *Capitella* sp. I came again in Otsuchi Center to study on the distribution of *Pseudomonas aeruginosa* in marine environments (Otsuchi Bay) in summer of 2008.

Professor Hamasaki Koji invited me as a visiting professor in AORI this time. I had been studied with him since 1990. I am very happy to have the opportunity to write this visiting report in AORI. I presented special lectures twice during my staying in AORI. The title of my first seminar was 'Tetrodotoxin history and recent trend', the second seminar was 'Detection of useful microorganisms from deep seawater and Korean fermented seafoods'. My research interesting points are now TTX-producing bacteria, useful LAB in Korean fermented food, deep seawater and marine microplastics recently.

photo after 1st seminar

This time I have been to visit the University of the Ryukyus for the information and communication of microplastics and deep seawater and also exchange programs. I fully discussed about the above titles with

Professors of Kogure (former AORI) and Tominaga in Okinawa. I visited Okinawa first time in my life. I spent wonderful time in Okinawa for 5 days.

Special thanks are given to AORI for supporting Fund. Furthermore, I discussed with Professors Michida and Kimura and Dr. Nomura to proceed the collaboration with international microplastics symposiums or workshops in both countries.

I am writing Tetrodotoxin review article, but it takes time to finish. Therefore, I fully discuss with Professor Hamasaki and download many TTX-related articles in AORI. I will never forget all the cheerful lunches and welcoming/farewell parties with Microbiology lab members. And I am particularly thankful to Prof. Hamasaki for his hospitality and also grateful to Ms Kobayashi for supporting me in all documents. Also, all thanks are given to the members of the Microbiology lab of AORI.



Plastics from various countries in Okinawa beach



Welcome party with Microbiology lab members in AORI

Glenn A. Milne

Department of Earth and Environmental Sciences
University of Ottawa
Professor

I am nearing the end of a very pleasant and productive six-week visit at the Atmosphere and Ocean Research Institute (AORI). I have been hosted by Prof. Yokoyama and his group, all of whom have been welcoming and helpful. This is my first visit to AORI and so the primary purpose was to initiate some projects that will hopefully result in several publications and a long-running and fruitful collaboration.

A key aspect of my visit has been to make available software for modelling and interpreting sea-level changes and land motion due to isostatic processes. Prof. Yokoyama and I have



complementary research skills that will be combined to improve our understanding of geodynamic processes in Japan and beyond. During my visit, I

have tutored two of Prof. Yokoyama's students in using my software and will work with them throughout the remainder of their projects.

One project relates to the use of sea-level observations to determine vertical land motion associated with tectonic processes. There is a rich database of ancient sea levels around Japan from which it is possible to determine rates of vertical land motion over different timescales (1-100 kyr). These rates can then be compared to those estimated more recently using GPS observations and repeated levelling. Changes in the rates over time provide insight to the underlying geodynamic processes – notably tectonics and isostasy – and, ultimately, an improved understanding of regional Earth structure and processes that will aid in hazard prediction. I presented two seminars on this topic – focusing on the Cascadia subduction zone – to interact with staff and students within and external to Prof. Yokoyama's group. I also initiated contact with Dr. Shaoyang Li – currently a JSPS Postdoctoral Fellow at the Earthquake Research Institute (Hongo Campus) who specialises in geodynamic modelling of subduction zones. His modelling will be highly complementary to this project and discussions are underway to collect new sea-level observations covering decadal to century time scales to better constrain his model.

A second project involves the interpretation of field observations that constrain the sea-level minimum (lowstand) during the last glacial maximum. Prof. Yokoyama led or participated in several of the

expeditions that produced these observations and so he has excellent insight to their strengths and limitations. A key application of these observations is to determine global ice volume during this important climate event. However, the resulting estimates give a value that is 10s of metres (in equivalent sea level) greater than that obtained from a complementary approach. This discrepancy is a major enigma for the paleoclimate community. Prof. Yokoyama and I have discussed possible solutions to this problem and on-going computer modelling experiments will test these ideas.

During my visit, Prof. Yokoyama was kind enough to invite me on a short field expedition to gather ocean water samples in the Tohoku region with one of his graduate students and colleagues at the International Coastal Research Centre. As a computer modeller, I don't get many opportunities to participate in field excursions and so this was a very welcome opportunity! The trip was highly educational in many respects. It presented my first opportunity to stay in a traditional Ryokan and eat a kaiseki meal – delicious! Also, I was able to see some of the impacts caused by the 2011 tsunami and was deeply touched by the severity of this disaster. The hard work and determination of the local people to recover from this life-changing event is truly inspiring.

To finish, I'd like to thank Prof. Yokoyama and his group for being warm and gracious hosts over the past six weeks. I very much enjoyed my visit from both a professional and personal perspective.

Neil C. Sturchio

*Department of Geological Sciences
University of Delaware, USA
Professor*



It was a great pleasure to work at AORI for one month with Prof. Yuji Sano and his research group. During my visit, I participated in two projects: (1) a noble gas radionuclide investigation of subsurface residence times of thermal and nonthermal groundwaters in the Mt. Ontake region, and (2) a nanoSIMS investigation of Pb interactions with the calcite (104) surface.

The first project is a collaborative study involving Prof. Yuji Sano, who has worked in the Mt. Ontake region for several decades, Dr. Reika Yokochi (University of Chicago, USA), Dr. Roland Purtschert (University of Bern, Switzerland), Dr. Zheng-Tian Lu (University of Science and Technology of China), and me. It requires extraction of dissolved gases from

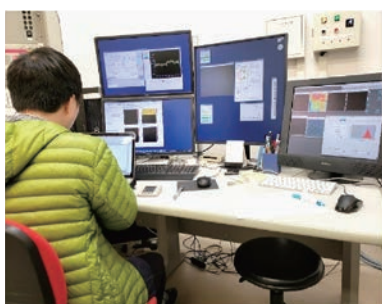
hundreds of liters of fluid to be able to obtain sufficient quantities of the noble gas radionuclides (krypton-85, krypton-81, and argon-39) for analysis by laser atom-trap magneto-optical methods. A variety of other measurements on the chemical and isotopic compositions of the samples will also be made on the collected water and gas samples to enable rigorous interpretation of the noble gas radionuclide results. There have yet been only a few applications of the noble gas radionuclides to geothermal systems, so this is a novel study and it should yield new insights into the hydrology of large volcanic landforms and the near-surface behavior of magmatic volatile emissions from magma chambers beneath the volcano. These data may ultimately be helpful in predicting volcanic eruptions.

The second project involves Argonne National Laboratory and my research group at the University of Delaware. We have been exploring the use of microfluidic techniques in monitoring reactions within defined microchannels under controlled flow rates and chemical conditions. The characterization of the

reacted calcite surface using the AORI nanoSIMS, in collaboration with Dr. Takahata and Dr. Miki, has provided a number of high-resolution maps of Pb distribution, that can be related to the products of dissolution-precipitation and adsorption-desorption reactions along the flowpath. The nanoSIMS data are highly complementary to the synchrotron X-ray fluorescence maps as well as scanning electron microscopy and atomic force microscopy images obtained for the same samples. These data will allow detailed thermodynamic and fluid dynamic modeling of this microfluidic reactive transport

system, as an analogue for the behavior of confined fluids in fractures and micropores of natural rock-water systems.

I was accompanied on this visit by my wife, Dolores, and we made several weekend sightseeing visits during our stay in Kashiwa – to Tokyo, Nikko, and Kyoto. It was interesting and enjoyable to learn more about the history of Japan and to experience the local food and culture. Overall, it has been a highly rewarding and productive visit, and I am grateful to Prof. Sano and his group and to AORI for this valuable opportunity.



Dr. Miki measuring Pb distribution in microfluidic channels at the calcite (104) surface with AORI's Cameca-50 nanoSIMS instrument.

Dr. Roland Purtschert of the University of Bern, Switzerland (left) and Dr. Reika Yokochi of the University of Chicago (right) preparing to sample geothermal gas emissions at the Nigorigo Onsen on the flank of Mt. Ontake volcano.



Andrew Hirst

University of Liverpool
Professor

I am fortunate to have spent the past 8 months working with colleagues at AORI, whilst on a Professorial Fellow, and am especially lucky to have worked alongside Prof Hiroaki Saito, and Dr Takahiro Irie. As an academic from a UK University (University of Liverpool) my normal routine is one of teaching, administration and periods of research. I have a varied, interesting and challenging day when in Liverpool, but one in which research must fill the time between other priorities. I know many will be familiar with such a tug-o-war on time. To have been able to spend a single, uninterrupted period, working exclusively on research whilst in Japan, has been a huge privilege. While spending my free time exploring the delights of the markets, museums and parks of Tokyo, the temples of Sendai and Kyoto, and skiing on Hokkaido at Christmas, has been a delight that I will never forget. I have enjoyed wonderful meals and new cuisine, a passion for me during my stay.

The research topics I have explored during my stay at AORI have been wide, and very much reflect my interests in rules and principals of ecology and evolution, often using aquatic taxa to explore them. I am fortunate in sharing many research interests

with Prof Saito, and we have explored our interested in marine pelagic copepods together. The pelagic environment, especially the sunlit-surface water, is a very risky one: the many hungry mouths and good eyesight of many predators, combines with few places to hide for their poor prey. Indeed, much indirect evidence points to predation being an important evolutionary structuring force in this special environment. Our work has explored this issue, especially in respect to those zooplankton in which females carry eggs attached to her body. Such parental care of course can protect vulnerable eggs, but may also put the females at elevated risk, especially as the eggs can be very visible to voracious predators such as fish. We have worked to produce the largest analysis to date on how pelagic copepod species are distributed by body size, vertical depth (i.e. from surface to deep dark environments), and how this varies between egg-carrying species and those with the contrasting strategy of shedding their eggs freely. Our work highlights possible evolutionary outcomes on egg-carrying species in terms of their body size being shifted smaller (possibly to safety) and how they more often reside in deeper, darker waters, than related egg-broadcasting species.

Other topics that I have completed at AORI include a meta-analysis of sexual size dimorphism (SSD) patterns in fish species, the most

comprehensive analysis of this type to date. Variation in the strength of SSD is generally considered to arise from differences in the relative intensity of male–male competition and fecundity selection (i.e. bigger females produce more eggs). Through a phylogenetic comparative analysis of fish, we set about testing whether SSD varied systematically with: (1) the intensity of sexual selection for increased male size, and (2) the intensity of fecundity selection for increased female size. We used records of body length at sexual maturity, and quantified variation in the magnitude and direction of SSD in more than 600 diverse freshwater and marine fish species, from sticklebacks to sharks. We found that although female-biased SSD is common, and this is thought to be driven by fecundity selection typically, variation in SSD was not dependent on either the strength of the body-mass dependence of reproduction in female fish. Instead, significant patterns based on habitat and life-history characteristics associated with male–male competition and paternal care, suggest that adaptive variation in SSD is driven by the intensity of sexual selection for increased male size. This work is now published: Horne CR, Hirst AG, Atkinson D (2020) Selection for increased male size predicts variation in sexual size dimorphism among fish species. *Proceedings of the Royal Society B* 287: 20192640. We hope will be well read and used by others, including many researchers at AORI interested in fish.

Most ectothermic ('cold-blooded') organisms mature at smaller body sizes when reared in warmer conditions. This phenotypically plastic response, known as the Temperature-Size Rule (TSR), is a taxonomically widespread patterns in biology, and seen in bacteria, protists, plants, invertebrates, fish and lizards. Working with Dr Takahiro Irie at AORI, we have been exploring how body size changes, and how the temperature-size response is generated in organisms in relation to the thermal dependence of growth and development rates. This has provided new insights and we hope to complete this work in the months ahead. I cannot thank Taka enough for our enjoyable times working and exploring together.

My return to the UK in the last few weeks (at the end of March 2020) coincided with the implementation of extreme measures to combat the Covid-19 virus. I passed through a near empty Haneda airport on a flight back to London, which was itself nearing lockdown. But I got home safe, and I vow to return to complete a spring cherry blossom tour of southern Japan that we had planned. I look forward to visiting the friends and colleagues that I have made during my stay at the University in the near future, when times will again be more relaxed. I will not forget the opportunities I have had that came from the great efforts of my generous host, Prof Saito. I wish you all a happy and prosperous year ahead.

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