GOA-ON

Global Ocean Acidification Observing Network

NOAA

IAEA

Ocean Acidification International Coordination Centre

OA-ICC

unesco

Intergovernmental Oceanographic Commission

Ocean Acidification Week 2021

A virtual multi-day forum to highlight different aspects of ocean acidification research and initiatives from around the world

13-17 September 2021

#OAWeek2021

Photo credit: Thomas Horig

Monday, 13 September 2021

Advancing the Ocean Acidification Information Exchange

Monday, September 13 at 09:00 EDT (UTC-4) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/8449999064703746828

Discussion Leader:

Ms. Julianna Mullen, NERACOOS, USA

Abstract: The Ocean Acidification Information Exchange (OAIE) is an online members-only forum dedicated to catalyzing response to ocean and coastal acidification through collaboration. The platform's tools are designed to make three major activities as simple as possible: sharing information, facilitating person-to-person connections, and keeping information organized and searchable. Online "communities of practice" like the OAIE are increasingly popular with professionals working toward shared outcomes in part because they're proven to be effective at accelerating discovery, and they can remove many barriers to participation associated with diverse geographic involvement. However, while the OAIE and others are positioned solely as professional environments built on a straightforward calculus of ask and answer, the psychology of community—the emotional reactions/responses of people sharing a space—is inextricably linked to the success of the collective and individual. Considering the OAIE's steady growth and ever-increasing diversity, plus the rising popularity of professional communities of practice in general, we will discuss what additional barriers to participation remain (technological and humanistic), how the OAIE and other communities can advance equitable access to resources, and how we as individuals interact with and benefit from community, especially through the lens of the pandemic.

North American Hub Session

Monday, September 13 at 12:00 EDT (UTC-4) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/559022914969106956

1. An Internally Consistent Data Product for Discrete Inorganic Carbon, Oxygen, and Nutrients on the North American Ocean Margins

Dr. Liqing Jiang, University of Maryland/National Centers for Environmental Information, National Oceanic and Atmospheric Administration (NOAA), USA
Language: English

Co-authors: Richard Feely (Pacific Marine Environmental Laboratory, NOAA, USA), Rik Wanninkhof (Atlantic Oceanographic and Meteorological Laboratory, NOAA, USA), Dana Greeley (Pacific Marine Environmental Laboratory, NOAA, USA), Leticia Barbero (Atlantic Oceanographic and Meteorological Laboratory, NOAA / University of Miami, USA), Simone Alin (Pacific Marine Environmental Laboratory, NOAA, USA), Brendan R. Carter (Pacific Marine Environmental Laboratory, NOAA / University of Washington, USA), Denis Pierrot (Atlantic Oceanographic and Meteorological Laboratory, NOAA, USA), Charles Featherstone (Atlantic Oceanographic and Meteorological Laboratory, NOAA, USA), James

Hooper (Atlantic Oceanographic and Meteorological Laboratory, NOAA / University of Miami, USA), Chris Melrose (Northeast Fisheries Science Center, NOAA, USA), Natalie Monacci (University of Alaska, Fairbanks, USA), Jonathan D. Sharp (Pacific Marine Environmental Laboratory, NOAA / University of Washington, USA), Shawn Shellito (University of New Hampshire, USA), Yuan-Yuan Xu (Atlantic Oceanographic and Meteorological Laboratory, NOAA / University of Miami, USA), Alex Kozyr (National Centers for Environmental Information, NOAA / University of Maryland, USA), Robert H. Byrne (University of South Florida, USA), Wei-Jun Cai (University of Delaware, USA), Jessica Cross (Pacific Marine Environmental Laboratory, NOAA, USA), Gregory C. Johnson (Pacific Marine Environmental Laboratory, NOAA, USA), Burke Hales (Oregon State University, USA), Chris Langdon (University of Miami, USA), Jeremy Mathis (Georgetown University, USA), Joe Salisbury (University of New Hampshire, USA), and David W. Townsend (University of Maine, USA)

We compiled, quality-controlled, and synthesized two decades of discrete measurements of inorganic carbon system parameters, oxygen, and nutrient chemistry data from the North American continental shelves to generate a data product called the Coastal Ocean Data Analysis Product in North America (CODAP-NA). New consistency checks and outlier detections were used to QC the data. Future releases of this CODAP-NA product will use this core data product as the basis for cruise-to-cruise comparisons. This version (v2021) of the CODAP-NA is comprised of 3391 oceanographic profiles from 61 research cruises covering all continental shelves of North America, from Alaska to Mexico in the west and from Canada to the Caribbean in the east. Data for 14 variables (temperature; salinity; dissolved oxygen content; dissolved inorganic carbon content; total alkalinity; pH on total scale; carbonate ion content; fugacity of carbon dioxide; and substance contents of silicate, phosphate, nitrate, nitrite, nitrate plus nitrite, and ammonium) have been subjected to extensive QC. CODAP-NA is available as a merged data product (https://www.ncei.noaa.gov/data/oceans/ncei/ocads/metadata/0219960.html). The original cruise data have also been updated with data providers' consent and summarized in a table with links to NOAA's National Centers for Environmental Information (NCEI) archives (https://www.ncei.noaa.gov/access/ocean-acidification-data-stewardship-oads/synthesis/NAcruises).

2. Capturing Marine CO_2 System Variability and Estimating Change Along the Inside Passage Using Observations From an Alaskan Ferry

Dr. Wiley Evans, Hakai Institute, Canada
Language: English

Co-authors: Geoffrey T. Lebon (Pacific Marine Environmental Laboratory, NOAA / University of Washington, USA), Christen D. Harrington (Alaska Department of Transportation, USA), Yuichiro Takeshita (Monterey Bay Aquarium Research Institute, USA), Allison Bidlack (University of Alaska Southeast, USA)

Information on marine CO_2 system variability has been limited along the Inside Passage of the Pacific Northwest despite the region’s rich biodiversity, abundant fisheries, and developing aquaculture industry. Beginning in 2017, the Alaska Marine Highway System M/V Columbia has served as a platform for surface underway data collection while conducting twice weekly ~1600-km transits between Bellingham, Washington and Skagway, Alaska. This effort provided the first characterization of the variability, severity, and timing of adverse pH and aragonite saturation state (Ω_{arag}) conditions across the region. Lowest pH was seen in confined tidally-mixed zones in autumn; whereas lowest Ω_{arag} was seen in areas of high glacial melt in summer. Time-of-detection estimates revealed the tidally-mixed zones to be sentinel observing sites with relatively short time spans of observation needed to capture seawater pCO_2 increase equivalent to the contemporary atmospheric CO_2 trend. Anthropogenic CO_2 estimates showed large time and space variability, the impacts of which were greater change in winter pH and larger change in summer Ω_{arag}. Differing spatial patterns of severe pH and Ω_{arag}, and the differential response to anthropogenic CO_2, likely have implications for vulnerable species and should be considered within the scope of tracking ocean acidification. Here we characterize the 1.5°C acidification level as the theoretical extent of acidification along the Inside Passage if society limits global warming to preferably 1.5°C as per the Paris Agreement, and show that half the acidification experienced thus far since the start of the industrial era is expected over the coming 15 years at our current atmospheric CO_2 trajectory.

3. Coral Reefs From the Mexican Pacific in the Context of OA (Arrecifes Coralinos Del Pacífico Mexicano En El Contexto De La AO)

Dr. Orion Norzagaray, Instituto de Investigaciones Oceanológicas-Universidad Autónoma de Baja California, Mexico
Language: Spanish, with English subtitles

Coral reefs and coral communities from the Eastern Tropical Pacific (ETP) develop under harsh conditions, since they live in environments with low temperature, high nutrient content and sub-saturated with regard to aragonite. These conditions convert this region, and the ecosystems inhabiting there, in natural laboratories for ocean acidification studies (OA) on corals. Studies on carbonate balance in these ecosystems indicate that they present low production values, commonly based on a small number of species. In addition, studies on the dynamics of the carbonate system in these environments highlight that the seasonal controls vary between regions, promoted by oceanographic processes, which have a local to regional footprint. This talk aims to show relevant aspects of the carbonate cycle in these environments, specifically those on the coasts of Mexico, and place them in the context of OA.

4. The Olympic Coast as a Sentinel: Communicating Best Practices From an Approach to Integrated Social-Ecological Vulnerability Assessments

Dr. Jan Newton & Dr. Melissa Poe, University of Washington, USA
Language: English

We present a place-based, transdisciplinary approach to assess ocean acidification vulnerability on a regional scale, highlighting a collaborative social-ecological research effort. Our study area, the Olympic Coast of Washington State, has been home for millennia to four coastal treaty tribes, and is already experiencing effects of ocean acidification, hypoxia, and marine heatwaves, which pose risks to marine resources that coastal communities and tribes depend on for their well-being. We bring together a variety of biophysical and social data across ocean spatial gradients and human systems to better understand the whole, to anticipate the effect of cumulative stressors, and to outline adaptive responses for healthy and resilient communities. Our place-based approach to assess regional vulnerability follows a process: scope local risk and priority needs; understand social importance of marine species; analyze variability in chemical and biological data; project future ocean conditions; assess frequency, duration, and location of harmful oceanographic events; evaluate risks to resources important to community partners; analyze socioeconomic conditions; assess social vulnerability to OA; identify community-driven strategies to respond to threats and increase adaptive capacity; provide critical information to decision-makers to prepare for and respond to OA vulnerabilities; monitor, evaluate, and reiterate. Working collaboratively, the project has strengthened regional partnerships, brought together a diverse constituency, and shown more deeply how connected things are and need to be going forward.

Photo credit: Jeff Hester

Pier2Peer: Tips on Fostering Successful Mentorships

Monday, September 13 at 16:00 EDT (UTC-4) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/2446977838370672143

Discussion Leader:
Dr. Kerri Dobson, NOAA OAP, USA

Abstract: Hear Pier2Peer mentors and mentees share their experiences in the GOA-ON mentorship program and learn tips for mentors and mentees on how to foster a successful mentorship.

Plenary Session #1: Ocean acidification from a global perspective

Monday, September 13 at 16:00 PDT (UTC-7) *View in various time zones*
Register here: https://attendee.gotowebinar.com/rt/1234246199885766670

1. GOA-ON and Ocean Acidification: A Global Perspective

Dr. Richard Feely, Pacific Marine Environmental Laboratory, NOAA, USA
Language: English

Co-authors: Dr. Brendan Carter (University of Washington, USA), Dr. Liqing Jiang (University of Maryland, USA)

The ocean's chemistry is changing due to the uptake of anthropogenic carbon dioxide (CO_2) from the atmosphere. Over the course of the last 270 years, the global oceans have absorbed approximately 160 ± 20 Pg C as carbon dioxide (CO_2), which is roughly 25-32% of the total CO_2 that has been released into the atmosphere by the combined effects of human activities. Upon exchanging with seawater at the air-sea interface, CO_2 undergoes a chemical reaction with seawater to form carbonic acid which increases the hydrogen ion concentration of seawater in a process known as ocean acidification (OA). Since the late 1980s, surface ocean pH has decreased by a range of -0.07 to – 0.17 per decade, with measurable regional trends. The decline in pH generally decreases with depth within the ocean interior but temporal changes in acidification can be observed to depths as much as 2000 m below the surface. Current projections indicate that by 2100 the pH of the surface water is expected to decrease by as much as -0.38 with substantial regional variations under the RCP8.5 CO_2 emission scenario. Over this century, it is anticipated that the seasonal amplitude of the H+ concentration will increase by as much as 80% under the same scenario.

2. Importance and Value of Monitoring Coastal Ocean Acidification in New Zealand

Dr. Kim Currie, National Institute of Water & Atmospheric Research Ltd (NIWA), New Zealand
Language: English

Co-authors: Judith Murdoch, University of Otago, New Zealand

The recent IPCC AR6 report stated that changes to the ocean including ocean acidification are clearly linked to human activity. A decline in pH has been observed in all ocean basins, and ocean acidification is virtually certain. In the New Zealand region of the South Pacific Ocean, as in other regions, the pH is predicted, with high certainty, to continue to decline. The IPCC is able to make these statements with the associated high level of confidence because of the meticulous ocean carbon chemistry measurements made by scientists from many countries over many years. However, establishing such trends with high certainty in coastal locations is more difficult because the scale of variability is high, and the time of emergence of any long -term trend is long. Many countries do not have the resources or expertise needed to start and maintain the long term observations needed to directly quantify any change in the coastal carbon chemistry due to anthropogenic drivers. GOA-ON is directly involved in addressing this, providing resources, protocols and training to enable equitable participation for countries to monitor the OA status of their own coastal environments. New Zealand, like many countries, has begun this process of establishing current day conditions with the aim of documenting the changing OA condition of our coastal waters over the long-term. The New Zealand Ocean Acidification Observing Network (NZOA-ON) collaborates with a variety of stakeholders and local communities to inform management of our coastal ecosystems.

Photo credit: Fabrice Dudenhofer

Tuesday, 14 September 2021

Plenary Session #2: Ecosystem response to ocean acidification

Tuesday, September 14 at 11:00 South Africa Standard Time (UTC+2) *View in various time zones*
Register here: https://attendee.gotowebinar.com/rt/2453427703405837

1. A Story of OA Research in South Africa

Dr. Carla Edworthy, The South African Institute for Aquatic Biodiversity, South Africa
Language: English

Co-authors: Dr. Nicola James (The South African Institute for Aquatic Biodiversity, South Africa), Prof. Warren Potts (Rhodes University, South Africa), Prof. Sam Dupont (The University of Gothenburg, Sweden)

Ocean acidification monitoring is still limited in South Africa, especially in our unique, productive and dynamic coastal areas. My talk will be a story of my journey with ocean acidification research in South Africa. I will discuss how we started our research on OA, how we progressed, how we made use of our opportunities and how we overcame several limitations. The talk will focus on our monitoring efforts and how we developed best practice methods for designing a simple and appropriate strategy for monitoring OA in an understudied region. I will also discuss how this information serves to assess the ecosystem effects of OA in South Africa, on coastal species and resources relevant to people. I will also add some thoughts for future research.

2. Impacts of Ocean Acidification on Coralline Algae

Dr. Chris Cornwall, Research Fellow & Lecturer, Victoria University of Wellington, New Zealand
Language: English

Co-authors: Steeve Comeau (Centre National de la Recherche Scientifique, France), Ben Harvey (University of Tsukuba, Japan), Lucia Porzio (University of Tsukuba, Japan)

Ocean acidification (OA) is a major threat to the persistence of biogenic reefs throughout the world's ocean. Coralline algae are comprised of high magnesium calcite and have long been considered one of the most susceptible taxa to the negative impacts of OA. In a recent meta-analysis/systematic review, we uncover some consistent and some inconsistent impacts of OA: most coralline algae experienced reduced abundance, calcification rates, recruitment rates, and declines in pH within the site of calcification in laboratory experiments simulating OA or at naturally elevated CO_2 sites. There were no other consistent physiological responses of coralline algae to simulated OA (e.g. photo-physiology, mineralogy and survival). OA is the dominant driver in the majority of laboratory experiments where other local or global drivers were assessed. The interaction between OA and any other single driver was often additive, though factors that changed pH at the surface of coralline algae (light, water motion, epiphytes) acted antagonistically or synergistically with OA more than any other drivers. Coral reefs will be severely impacted by ocean warming and associated marine heatwaves. Reefs that could fair well under marine heatwaves currently have high contributions of coralline algae. However, the ability of these reefs to continue to calcify will be threatening by intensifying OA.

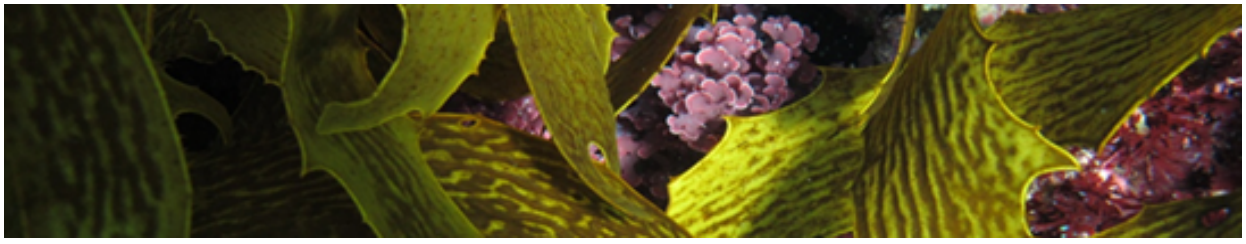


Photo credit: Chris Cornwall

Mediterranean Hub Session

Tuesday, September 14 at 13:00 CEST (UTC+2) *View in various time zones*
Register here: https://attendee.gotowebinar.com/rt/1209881022214429710

1. Ocean Acidification at the Crossroads: Approaching Unpurified and Purified M-Cresol Spectrophotometric pH Measurements

Dr. Marta Álvarez, Instituto Español de Oceanografía-El Consejo Superior de Investigaciones Científicas, Spain
Language: English or Spanish

Co-authors: Rubén Acerbi-Amigo, Noelia M. Fajar, and Elisa F. Guallart (Instituto Español de Oceanografía-El Consejo Superior de Investigaciones Científicas)

The spectrophotometric pH method was firstly published in 1993 and the corresponding Standard Operation Procedure in 2007. However, seawater pH is loosely quality controlled due to the lack of reference materials and a well established metrology. Additionally, impurities in the dye seam to interfere with the pH quantification, specially for high pH waters. A procedure was published to overcome this difficulty. Here we will present and discuss i) the direct comparison of pH measurements with unpurified and purified m-cresol dye over a range of oceanographic conditions; ii) the correction of unpur to pur dye pH estimates using the published method and iii) study the pH measurement and internal consistency improvement using pur dye.

2. Coastal Acidification Trends in the Gulf of Trieste (Northern Adriatic Sea)

Dr. Michele Giani, National Institute of Oceanography and Applied Geophysics (OGS), Italy
Language: English

Co-authors: Lidia Urbini, Carolina Cantoni, Anna Luchetta, Stefano Cozzi, Massimo Celio, Cinzia De Vittor, Martina Kralj

Two monthly time series of the carbonate system parameters were analyzed in the Gulf of Trieste, the northernmost coastal zone of the Mediterranean Sea, in a riverine influenced area, to detect trends. Water sampling was carried out at PALOMA Station, in the middle of the Gulf, from March 2009 to February 2020 and at C1-Miramare Station, close to the coast, from March 2011 to February 2020. Both sites are included in GOA–ON and ICOS-RI networks. pH and total alkalinity were measured by spectrophotometry and open cell potentiometric titration respectively, on water samples collected at four depths. The other parameters of the carbonate system were calculated using the software CO2Sys. Preliminary results show that, at both sites, the pH anomaly (i.e. deviation from the monthly mean) decreased by 0.002-0.004 units/yr. At both sites, pH at constant temperature of 25°C was inversely correlated with apparent oxygen utilization, showing a relevance of primary production and respiration processes on the carbonate system. Median pH (8.089-8.111) was lower at the bottom with the widest variability (interquartile range 0.100-0.167), due to respiration processes.

3. *Title tbd*

Mr. Saul Ciriaco, L'Area Marina Protetta di Miramare, Italy
Language: English

4. Ocean Acidification and the European Science-Policy Landscape

Dr. Ana Rodríguez & Dr. Sheila Heymans, European Marine Board, Spain
Language: English

The presentation will provide an overview of the current state of European policies and legislation targeting Ocean Acidification, and provide recommendations from a science-policy perspective.

Photo credit: Katerina Katopis

Impacts of OA on marine fungi - a community discussion

Tuesday, September 14 at 19:00 IST (UTC+5:30) *View in various time zones*
Register here: https://register.gotowebinar.com/#register/5903691763135501839

Discussion Leader:
Mr. Parth Arora, Pondicherry University, India

Abstract: The impacts of ocean acidification (OA) to marine ecosystems has been documented across the globe. While many species have been found to be negatively impacted by OA, some are able to benefit (e.g., sea grasses) and can sequester ocean carbon. The impacts of OA on zoonotic pathogens and marine fungi is an emerging field, but evidence suggests that marine fungi may also benefit from OA. We will discuss the observed and reported impacts of OA on marine fungi and their interactions with water quality, and encourage participants to share observations from their own research. We will then work together to identify gaps in OA-marine fungi research, and develop a protocol for conducting future research on the topic. By bringing together marine mycologists interested in OA, we hope to create an OA/marine mycologist Community of Practice which will collaborate to develop this field further.

LAOCA (Latin American and Caribbean) Hub Session

Tuesday, September 14 at 13:00 Argentina Time (UTC-3) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/7729640827626841356

1. Observatory for the Study of OA in Cuba: First Results and Challenges for Its Sustainability

Mr. Miguel Gomez Batista, Centro de Estudios Ambientales, Cuba
Language: Spanish

Co-authors: Yusmila Helguera Pedraza (Centro de Estudios Ambientales de Cienfuegos), Carlos M. Alonso Hernández (Centro de Estudios Ambientales de Cienfuegos), Joán Hernández Albernas (Centro de Estudios Ambientales de Cienfuegos), Luis Angel Aragón López (Centro de Estudios Ambientales de Cienfuegos), Dariadelis Reyes Noa (Centro de Estudios Ambientales de Cienfuegos), Elianet Pérez Pérez (Centro de Estudios Ambientales de Cienfuegos), Dismey Sosa Rodríguez (Centro de Estudios Ambientales de Cienfuegos), Alain Muñoz Caravaca (Centro de Estudios Ambientales de Cienfuegos)

The phenomenon of ocean acidification has generated great global attention due to the threat it represents to the sustainability of marine ecosystems. From the collaboration with the International Atomic Energy Agency and the co-financing of the Ministry of Science Technology and Environment of Cuba, the Observatory for the Study of Ocean Acidification was inaugurated (2017) in Cienfuegos. The

talk will present the organizational structure of the observatory. Currently the observatory has operational capabilities for the determination of Total Alkalinity and pH with weather quality and is in the process of assembling the determination of Dissolved Inorganic Carbon (DIC). The first results achieved during the period 2019 to 2020 are presented, including the first report to SDG14.3.1 and the satisfactory results achieved in the intercomparison round organized by QUASIMEME (AQ-15, round 1). The observatory's researchers are part of the REMARCO and LAOCA networks.

2. Ocean Acidification Modelling in the Mexican Pacific

Dr. Leticia Espinosa Carreón, Instituto Politécnico Nacional - CIIDIR Sinaloa, Mexico
Language: Spanish

Co-authors: J. Martín Hernández-Ayón (IIO-UABC), Orion Norzagaray (IIO-UABC), Lourdes Coronado-Álvarez (IIO-UABC), Cecilia Chapa (UMAR), Rosalba Alonso-Rodríguez (ICML-UNAM), David U. Hernández-Becerril (ICML-UNAM), Víctor H. Martínez-Magaña (INAPESCA), Selene Morales-Gutiérrez (INAPESCA), Diana C. Escobedo-Urías (IPN-CIIDIR Sinaloa), A. Itahi De la Cruz-Ruiz (IPN-CIIDIR Sinaloa), Yamili A. Caraveo-Covarrubias (IPN-CIIDIR Sinaloa), Lizbeth N. Guzmán-Santos (IPN-CIIDIR Sinaloa), Madeline G. Molina-Ortega (IPN-CIIDIR Sinaloa), Perla G. Silva-Herrera (IPN-CIIDIR Sinaloa), Lorena Flores-Trejo (IIO-UABC), Pedro Morales-Urbina (IPN-CIIDIR Sinaloa), Saúl Álvarez-Borrego (investigador independiente)

With the support of the Secretariat of the Navy, Mexican Navy (SEMAR) and the National Institute of Fisheries and Aquaculture (INAPESCA), it has participated in 13 oceanographic cruises from Tijuana, BC, to Chiapas, covering the entire Mexican Pacific since 2016 to 2021. Six students are developing their Master of Science and PhD thesis. Some of the results obtained are presented. In 2016, CO_2 sequestration was recorded in five of six areas of the Gulf of California. In the tropical Pacific zone, it was registered in April 2017 as a source of CO_2, while, in the same region, in April 2018, a sink. In the Baja California Sur region in 2019, the relationship between DIC and water masses was presented. In Baja California and Baja California Sur, a latitudinal transect shows the sinking of the isotherms and the influence of the water of the California Current from north to south, as well as the latitudinal variation of some species of coccolithophores.

3. Diseño de Monitoreo: Química de Carbonatos Frente al Ecuador

Ms. Patricia Macías Mora, Instituto Público de Investigación en Acuicultura y Pesca, Ecuador
Language: Spanish

El Instituto Público de Investigación en Acuicultura y Pesca a través del programa institucional denominado Variabilidad climática, genera un sistema de monitoreo de variables físico químicas y biológicas relevantes para determinar la acidificación del océano en dos sitios frente a la costa ecuatoriana, Salinas y Puerto López, aplicando los procedimientos operacionales estandarizados (SOP) para muestras de agua.

4. Ocean acidification research in the Southwestern Atlantic Ocean

Dr. Paulo Horta, Universidade Federal de Santa Catarina, Brazil
Language: English

Co-authors: Rodrigo Kerr (Universidade Federal do Rio Grande, Brazil), Leticia Cotrim da Cunha (Universidade do Estado do Rio de Janeiro, Brazil)

Brazil's Economic Exclusive Zone (EEZ) extends from 5o N to 33o S along more than 8,000 km and corresponds to 3.5 million km². This huge marine area is also called the "Blue Amazon"; it is rich in biodiversity, fisheries resources, growing aquaculture, and key ecosystems such as mangroves, coral reefs, seamounts, seagrass meadows, rhodolith beds provide services such as shore protection, carbonate deposits and atmospheric CO_2 sink. The Brazilian Ocean Acidification Network (BrOA; www.broa.furg.br) comprises 41 associated researchers from 9 Brazilian institutions, distributed along almost all country regions. The network has been working on local monitoring in LTER programs, regional ocean

observational initiatives, experimental and modelling efforts to investigate trends and impacts of OA in the western South Atlantic Ocean (WSAO). Besides important advances with some isolated monitoring programs and experimental facilities, Brazil still experiences knowledge gaps, infrastructure deficiencies, and other OA-related issues in the WSAO. This presentation outlines the main BrOA network results and advances in the last 10 years, as well as our challenges facing marine ecosystem management in Brazil's EEZ through the UN Ocean Decade and under a climate change scenario and a hostile government environmental agenda.

5. Role of marine macroalgae in the pH regulation in an eutrophic Argentinean coastal area

Dr. María Eugenia Becherucci, Laboratorio de Ecología, Instituto de Investigaciones Marinas y Costeras (IIMyC: UNMdP-CONICET), Argentina
Language: Spanish

Co-authors: Dr. Paulina Martinetto (Laboratorio de Ecología, IIMyC), Dr. Eugenia Fanjul (Laboratorio de Ecología, IIMyC), Dr. Oscar Iribarne (Laboratorio de Ecología, IIMyC), Dr. Maite Narvarte (Centro de Investigaciones Marinas Almirante Storni, San Antonio Oeste), Dr. Patricio Pereyra (Centro de Investigaciones Marinas Almirante Storni, San Antonio Oeste)

Nutrient input drives macroalgal blooms and increases in photosynthetic activity in coastal ecosystems. An intense macroalgal photosynthetic activity can increase the surrounding pH and counteract the acidification that often follows an eutrophication process. This hypothesis was tested with field sampling and experiments in a macrotidal (up to 9 m in amplitude) coastal system within a semi-desert region with contrasting eutrophic conditions and *Ulva lactuca* blooms in the northern Argentinean Patagonia (San Antonio Bay). The results indicate that daily pH variability during low tide could be controlled by the photosynthetic activity of *Ulva lactuca* under eutrophic conditions. At seasonal scale, the pH variations were related to environmental features, particularly seawater temperature. Both environmental (i.e. high solar radiation, negligible freshwater inputs and large tidal action) and anthropogenic nutrient inputs into the studied area promote the *Ulva lactuca* blooms, which in turn increases the surrounding pH in well oxygenated seawater through the intense photosynthetic activity.

Photo credit: Hugh Whyte

Introducing the New Pacific Islands Regional OA Training Hub and Other Upcoming Capacity Development Activities

Tuesday 14 September at 7pm EDT (UTC-4) / Wednesday, September 15 at 11:00 Fiji Time (UTC+12)
View in various time zones
Register here: https://register.gotowebinar.com/#rt/2367390788708283405

Discussion Leaders:
Ms. Alexis Valauri-Orton, Ms. Courtnie Park, & Dr. Kaitlyn Lowder, The Ocean Foundation, USA
Dr. Michael Acquafredda, Dr. Kerri Dobson, & Ms. Meredith Kurz, NOAA, USA
Dr. Katy Soapi, Secretariat of the Pacific Community (SPC), Fiji
Dr. Kim Currie, National Institute of Water and Atmospheric Research (NIWA), New Zealand
Dr. Gilianne Brodie & Dr. Antoine De Ramon N'Yeurt, The University of the South Pacific (USP), Fiji

Abstract: Are you a researcher or student based in the Pacific Islands? Are you looking for training, equipment, and other support? This community discussion session will provide information and updates about on-going capacity development activities organized by the TOF, NOAA, and the US Department of State.
Their goal is to enhance and sustain ocean acidification monitoring and research capacity in the Pacific Islands region. Come to this session to learn about:

- a new Regional Training Hub in Suva, Fiji, hosted by the Institute of Applied Science at USP, SPC, NIWA, and the University of Otago (UO)
- an upcoming Ocean Teachers Global Academy training
- an RFP for OA monitoring equipment grants, specifically geared toward Pacific Islanders
- a Masters Student Fellowship, specifically geared toward Pacific Islanders

There will be an extended Question and Answer panel discussion, and interested audience members will be given ample opportunities to ask questions and share their thoughts.

Photo credit: Tom Vierus

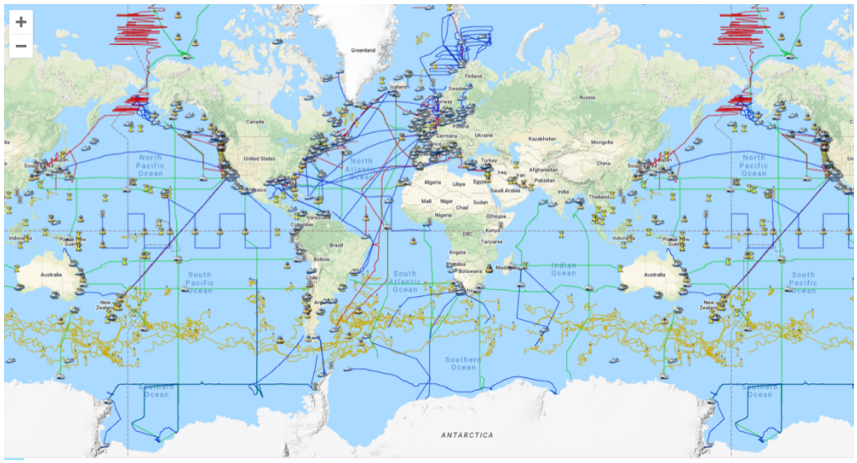
Wednesday, 15 September 2021

OA Data Sharing - GOA-ON Data Explorer and the SDG 14.3.1 Portal

Wednesday, September 15 at 11:00 CEST (UTC+2) *View in various time zones*
Register here: https://attendee.gotowebinar.com/register/4526313755948751371

Discussion Leaders:
Mr. Trevor Eakes, GOA-ON Secretariat, International Atomic Energy Agency, Monaco
Dr. Katherina Schoo, GOA-ON Secretariat, Intergovernmental Oceanographic Commission of UNESCO, France
Dr. Kerri Dobson, GOA-ON Secretariat, NOAA OAP, USA

Abstract: Join our community discussion where we will introduce the GOA-ON Data Explorer (http://portal.goa-on.org/Explorer) and the SDG 14.3.1 Data Portal (https://oa.iode.org/), two community based online tools to showcase and share your ocean acidification observations. We invite all researchers working on ocean acidification, data managers, scientists with geospatial backgrounds and those working on open science to discuss innovative approaches and solutions for the development of data portals in the coming decade. We will consider questions such as: how can ocean acidification data portals evolve to meet the challenges of the coming decade? What new sources of information could be incorporated? What visualizations would you find helpful? How can we better incentivize and inspire scientists to submit and share their data? What technical resources are available to us? GOA-ON is looking to establish a working group focused on ocean acidification data sharing and the strengthening of the GOA-ON Data Explorer – all interested are welcome to join and contact the Secretariat at secretariat@goa-on.org.



Africa Hub Session

Wednesday, September 15 at 13:00 Central Africa Time (UTC+2) *View in various time zones*
Register here: https://attendee.gotowebinar.com/rt/5316072067365111566

1. New Marine Observations of Carbonate Chemistry Variability and Ocean Acidification State in North West Africa Waters

Dr. Mohammed Idrissi, National Institute of Fisheries Research (INRH), Morocco
Language: English

Co-authors: Melissa Chierici and Helene Lødemel (Institute of Marine Research, Norway), David Cervantes (Institute of Marine Research, Norway), Ismail Bessa, Abdelaziz Agouzouk, Ahmed Makaoui

and Omar Ettahiri (National Institute of Fisheries Research, Morocco), Bouya Mbengue and Dia Abdoul (Institut Mauritanien de Recherches Océanographiques et de Pêches, Mauritania), Saliou Faye (Institut Sénégalais de Recherches Agricoles, Sénégal), Beat Gasser and Peter Swarzenski (International Atomic Energy Agency, Monaco)

The Canary Current Large Marine Ecosystem (CCLME) region supplies very significant local and international fish resources, based largely on small pelagic fish and artisanal fisheries. Especially on the North West Africa Atlantic Sea, the fishery market contributes to the economy of the region bordering this sea and provides important food and employment to coastal communities. In 2017, the 30-year long EAF Nansen Program (FAO and Norway), began with studies on ocean acidification along the CCLME region. Here, we show the first results of the ocean acidification state from this new research theme focusing on the North West Africa waters (from Morocco (35°N) to Senegal (12°N). Between May 2017 and December 2019, samples were measured, in this region, onboard the R/V Dr. Fridtjof Nansen for total alkalinity and pH using potentiometric titration and spectrophotometric pH measurements, respectively. The other parameters describing the carbonate chemistry and ocean acidification state were derived from AT and pH, using the CO2SYS calculation program. The survey was performed at twenty-seven sections perpendicular from the coast (the mesopelagic transect included) with a total of 110 stations in the full water column. We found large variability along the coast, connected to salinity changes, primary production, temperature and biological processes.

2. The Gulf of Guinea Marine Ecosystem in a Changing Ocean: overview and challenges

Dr. Sheck A. Sherif, Environmental Protection Agency of Liberia, Liberia
Mr. Falilu Adekunbi, Nigerian Institute for Oceanography and Marine Research, Nigeria
Language: English

Co-authors: Patrizia Ziveri (Universitat Autònoma de Barcelona, Spain), Michael Grelaud (Universitat Autònoma de Barcelona, Spain), Kai Schulz (Southern Cross University, Australia)

The Gulf of Guinea is a productive marine ecosystem fueled by seasonal coastal upwelling that supports huge fisheries and economic livelihoods for societies in West Africa. The present study aims to elucidate the Gulf of Guinea's past and current response to global ocean changes. Monthly MODIS-Aqua Sea Surface Temperature Anomalies (SSTA) and mean chlorophyll-a variability for 2003 to 2020 was used to investigate upwelling events. To understand the Gulf of Guinea's vulnerability to global change impacts and productivity variations leading to food security challenges, the evolution of future upwelling in terms of stratification caused by warming is discussed. Upwelling intensification either accentuates or dampens ocean acidification. With projected population growth by 2050 and a reduction in maximum fish catch in tropical regions co-occurring with stratification-induced nutrient depletion, comprehensive modeling is needed to improve upwelling for fisheries management and socio-economic systems in the Gulf of Guinea.

3. Ocean acidification monitoring in Kenya

Dr. Eric Okuku, Kenya Marine and Fisheries Research Institute, Kenya
Language: English

Co-authors: Venonica Wanjeri, Gilbert Owato, Linet Kiteresi, Keneth Otieno, Mary Mbuche and Maureen Mokeira Kombo

Tropical mangrove forests, seagrass beds, and coral reefs are among the most diverse and productive marine ecosystems in Kenya. They play an important role in provision of goods and service that immensely contribute to food security, employment and supporting livelihoods and local economy. These habitats are however distributed heterogeneously in the coastal zone, at shallow depths where perturbations in the carbonate system can have the greatest influence on water chemistry and air-sea carbon dioxide (CO_2) exchange thus affecting their functioning. We have been monitoring the carbonate chemistry in in these habitats in the Kwale, Mombasa and Kilifi Counties in Kenya from 2019-2021. We have additionally investigated the impacts of Ocean acidification on growth of *Telebraria palustris*. We will be sharing the results obtained so far in these studies in our presentation.

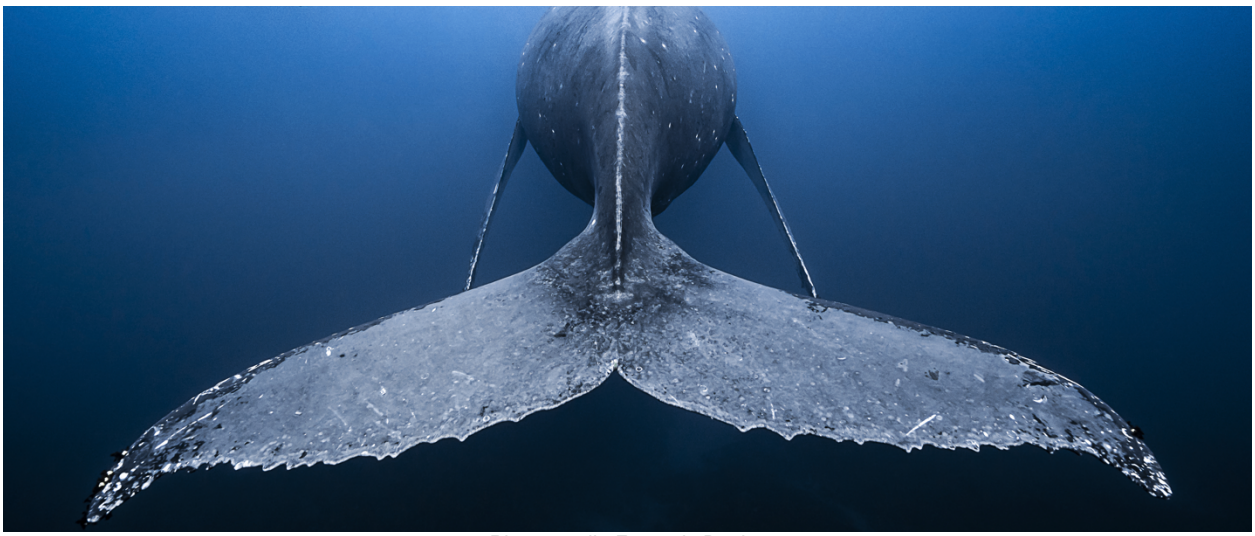


Photo credit: Francois Baelen

Plenary #3: Modelling ocean acidification

Wednesday, September 15 at 09:00 EDT (UTC-4) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/4884691874154247182

1. Regional Attribution of Coastal Processes to Ω, pH, and Carbon Variability in Washington and Oregon Waters: A Modeling Study

Dr. Samantha Siedlecki, Assistant Professor of Marine Sciences, University of Connecticut, USA
Language: English

Co-authors: Pilcher, D. (NOAA PMEL, CICOES), Howard, E. (University of Washington, USA), Deutsch, C. (University of Washington, USA), MacCready, P. (University of Washington, USA), Norton, E. (University of Washington, USA), Frenzel, H. (University of Washington, USA), Newton, J. (University of Washington, USA), Feely, R.A. (NOAA PMEL), Alin, S.R. (NOAA PMEL), Klinger, T. (University of Washington, USA)

Corrosive and hypoxic events in coastal waters are of increasing concern to local fisheries. Many important species (oysters, crabs, phytoplankton, zooplankton) in Washington and Oregon coastal waters are currently experiencing or are expected to feel effects of ocean acidification. Direct effects have been observed on the $100 million shellfish industry, and additional indirect economic impacts could impact the finfish industry through loss of prey species. Recent findings from the West Coast Ocean Acidification and Hypoxia Panel and the Washington Blue Ribbon Panel Addendum emphasize the need to use models to assess probable future conditions at local and regional scales. It is now possible to simulate important processes for regional Ω, pH, and hypoxia variability due to the higher spatial and temporal resolution of models combined with more comprehensive observations. The ability to predict the intensity of hypoxic and corrosive conditions, spatial variability of these conditions, and changes in their duration could be of considerable benefit to managers. These abilities require models to forecast and project variability with accurate representations of processes important to determining that variability. A suite of forecast and projections have been in development for the Pacific Northwest coast including a short-term forecast (LiveOcean, 72 hour) and some high-emissions scenario projections out to 2100. These simulations enable us to attribute regional variability to important processes like regional freshwater influence, water column metabolism, and changes in buffer capacity. The simulations also allow us to explore impacts of future emission scenarios on the regional expression of those processes within the context of Ω and pH variability on a range scales. In this work, we discuss methods for evaluating model forecasts and projections to ensure they achieve well-simulated conditions for the right reasons, showcase results of simulating important processes attributed to determining variability in the region, and determine the implications for these processes in a future scenario. Our results will shed light on the extent and timing of

the risks to local ecosystems and provide critical guidance to those concerned with mitigation of and adaptation to the threat of ocean acidification.

2. Modeling Ocean Acidification Progression in the Gulf of Mexico During Recent Decades

Dr. Fabian Gomez, Research Scientist, Northern Gulf Institute, Mississippi State University & Atlantic Oceanographic and Atmospheric Laboratory, NOAA, USA
Language: English

Co-authors: Rik Wanninkhof (Atlantic Oceanographic and Meteorological Laboratory, NOAA, USA), Leticia Barbero (Atlantic Oceanographic and Meteorological Laboratory, NOAA / University of Miami, USA), Sang-Ki Lee (Atlantic Oceanographic and Meteorological Laboratory, NOAA, USA)

Ocean Acidification (OA) progression is affected by multiple factors, such as ocean warming, biological production, and river runoff. Here we used an ocean-biogeochemical model to examine the drivers of the OA spatiotemporal variability in the Gulf of Mexico (GoM) during 1981-2014. The model showed negative pH and aragonite saturation state trends (ΩAr), linked to increasing levels of atmospheric CO_2, which were close to values reported for the Subtropical North Atlantic. However, significant departures from the basin-mean trends were obtained over the northern GoM inner shelf, where the sign of the trends was positive. Model sensitivity analyses showed that OA progression in this last region was counteracted by enhanced alkalinity from the Mississippi-Atchafalaya River System (MARS). The model results also showed interdecadal changes in the OA indicators linked to the 1997-98 climate shift. We detected a stronger OA in the northern GoM shelf during 1999-2014, driven by interdecadal changes in the MARS's ratio of alkalinity to dissolved inorganic carbon. Away from the northern GoM shelf, surface warming during 1981-1998 and a weak surface cooling during 1999-2014 promoted a stronger positive trend for ΩAr while counteracted the trend changes for pH and partial pressure of CO_2. Our findings highlight that river alkalinity is a key driver of the low-frequency carbon system variability and emphasize the need for considering realistic freshwater chemistry fluxes to properly assess acidification in coastal waters.

Photo credit: Jordan Robins

Arctic Hub Session

Wednesday, September 15 at 11:00 EDT (UTC-4) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/6006367457322817294

1. Integrated Assessment of the Risks to Ocean Acidification in the Northern High Latitudes: Regional Comparison of Exposure, Sensitivity and Adaptive Capacity of Pelagic Calcifiers

Dr. Nina Bednarsek, Southern California Coastal Water Research Project (SCCWRP), USA
Language: English

Co-authors: Kerry-Ann Naish (University of Washington, USA), Richard Feely (Pacific Marine Environmental Laboratory, NOAA, USA), Claudine Hauri (International Arctic Research Center, Norway), Katsunori Kimoto (JAMSTEC, Japan), Albert J. Hermann (University of Washington, USA), Christine Miche (Fisheries and Oceans, Canada), Andrea Niemi (Fisheries and Oceans, Canada), Darren Pilcher (University of Washington, USA)

Exposure to the impact of ocean acidification (OA) is increasing in high-latitudinal productive habitats. Pelagic calcifying snails (pteropods), a significant component of the diet of economically important fish, are found in high abundance in these regions. This presentation will focus on the integrated risk assessment in the Eastern Pacific subpolar gyre, including the Gulf of Alaska (GoA), Bering Sea, and Amundsen Gulf. The risk for pteropod populations was determined by integrating measures of OA exposure, biological sensitivity, and resilience. Exposure was based on physical-chemical hydrographic observations and regional biogeochemical model outputs. Biological sensitivity was based on pteropod morphometrics and shell-building processes, including shell dissolution, density and thickness. Resilience and adaptive capacity were based on species diversity and spatial connectivity, derived from the particle tracking modelling. An integrated risk evaluation based on multiple approaches assumes a high risk for pteropod population persistence with intensification of OA in the high latitude eastern North Pacific. Such comprehensive understanding would permit improved prediction of ecosystem change relevant to effective fisheries resource management, as well as a more robust foundation for monitoring ecosystem health and investigating OA in high-latitudinal habitats.

2. Model Projections of Ocean Acidification in the Arctic

Dr. Nadja Steiner, Fisheries and Oceans Canada, Canada
Language: English

Co-authors: Cathy Reader (Fisheries and Oceans Canada), Tessa Sou (Fisheries and Oceans, Canada), Johanna Laenger (University of Victoria, Canada)

We will present an evaluation of regional trends in ocean acidification and accompanying environmental stressors for the Arctic. Evaluations will be presented for historical and projection runs and for a variety of CMIP5 and CMIP6 models and scenarios. The models tend to show high consistency in ocean acidification trends, but differ in their initial conditions, which leads to constant biases among the models. Model projections show little difference for different scenarios over a 10-20year timescale, but diverge afterwards with clear differences in ocean acidification for high and low emission scenarios. Several regions show continuous aragonite under-saturation already within the historical time period (before 2015).

3. Arctic Ocean acidification over the 21st century co-driven by anthropogenic carbon increases and freshening in the CMIP6 model ensemble

Dr. Jens Terhaar, University of Bern, Switzerland
Language: English

Co-authors: Olivier Torres (Sorbonne Université, France), Timothée Bourgeois (Norwegian Research Centre and Bjerknes Centre for Climate Research, Bergen, Norway), Lester Kwiatkowski (Sorbonne Université, France), Laurent Bopp (Sorbonne Université, France)

The Arctic Ocean is particularly vulnerable to ocean acidification due to its naturally low pH and saturation states. Here, we analyse ocean acidification in the Arctic Ocean over the 21st century across models from the latest Coupled Model Intercomparison Project Phase 6 (CMIP6). Compared to the previous model generation (CMIP5), models generally better simulate maximum sea surface densities in the Arctic Ocean and consequently the transport of anthropogenic carbon (C_{ant}) into the Arctic Ocean interior. Moreover, in CMIP6 the inter-model uncertainty of projected changes over the 21st century in Arctic Ocean saturation states of aragonite (Ω_{arag}) and calcite (Ω_{calc}) averaged over the upper 1000 m is reduced by 44–64 %. The strong reduction in projection uncertainties of Ω_{arag} and Ω_{calc} can be attributed to compensation between C_{ant} uptake and total alkalinity reduction in the latest models. Specifically, models with a large increase in Arctic Ocean C_{ant} over the 21st century tend to simulate a relatively weak concurrent freshening and alkalinity reduction, while ESMs with a small increase in Cant simulate a relatively strong freshening and concurrent total alkalinity reduction. Even under the low-emissions Shared Socioeconomic Pathway 1-2.6 (SSP1-2.6), basin-wide averaged Ω_{arag} undersaturation in the upper 1000 m occurs before the end of the century.

4. Modern State of the Aragonite Saturation and Carbon Dioxide Fluxes in the Kara and Laptev Seas

Dr. Alexander Polukhin, Shirshov Institute of Oceanology, Russian Academy of Sciences, Russian Federation
Language: English

Co-authors: Georgy Gusak (St.Petersburg State University, Russia), Julia Pronina (Shirshov Institute of Oceanology, Russia), Svetlana Stepanova (Shirshov Institute of Oceanology, Russia), Natalia Pankratova (Obukhov Institute of Atmospheric Physics, Russia), Igor Belikov (Obukhov Institute of Atmospheric Physics, Russia), Valeria Muravya (Shirshov Institute of Oceanology, Russia), Mikhail Flint (Shirshov Institute of Oceanology, Russia)

The processes occurring in the areas of the outer shelf and the continental slope of the Siberian epicontinental seas play a huge role in the regulation of the biogeochemical regime and substance fluxes, and the formation of biological productivity. These processes are associated with current climatic trends, since it is in the area of the Arctic continental slope that the current trend of a decrease in ice cover and an increase in the duration of the ice-free period in the Arctic is most pronounced. One of the most important characteristics of matter fluxes in Arctic ecosystems is the exchange of carbon dioxide at the ocean-atmosphere interface. As a result of our studies, it became obvious that, over a significant latitudinal extent of the water in the area of the outer shelf and continental slope of the Kara and Laptev seas, in the summer season, CO_2 flows from the atmosphere into the surface layer of the sea. And the main factor affecting the aragonite saturation on the shallow shelf of the seas is the river runoff due to an increase in the removal of carbon in various forms from the land.

5. Ocean Acidification Dynamics in the Marginal Ice Zone of the Barents Sea and Arctic Ocean

Dr. Libby Jones, Institute of Marine Research, Norway
Language: English

Co-authors: M. Chierici (Institute of Marine Research, Norway), A. Fransson (Norwegian Polar Institute, Norway), H. Hodal Lødemel (Institute of Marine Research, Norway), Y. Ericson (Norwegian Polar Institute, Norway)

Seasonal cycling in carbon and nutrients, with implications for ocean acidification, was investigated in the context of changes in sea ice cover, meltwater inputs, mixing and biological processes in the Barents Sea and Arctic Ocean (Nansen Basin). In August 2019, the summer ice edge was located 80N and the upper water column was generally warm and fresh. Primary production had reduced concentrations of nutrients and dissolved inorganic carbon (CT), particularly in the ice-free waters. North of the ice edge, meltwater inputs reduced total alkalinity (AT), the chemical buffering capacity of seawater, through dilution. By December, the winter ice pack extended to 78N and created more Arctic-like conditions. Mixing and remineralisation resulted in increased concentrations of nutrients and CT in the water column. The imprint of summer processes was observed with lower CT and AT in ice-covered surface waters. The central

Barents Sea revealed low seasonality, where reduced AT and Arctic-like conditions characterised the water column. Atlantic Water inflow in the south and north supplied the surface layer with AT to counteract acidification effects. Future warming, loss of sea ice and Atlantification likely enhance biological carbon uptake, reduce effects of meltwater dilution and buffer against acidification in the Barents Sea. This study is a contribution to the Nansen Legacy project.

Photo credit: Toby Matthews

PITOA (Pacific Islands and Territories) Hub Session

Wednesday, September 15 at 7pm EDT (UTC-4) / Thursday, September 16 at 11:00 Fiji Time (UTC+12)
View in various time zones
Register here: https://register.gotowebinar.com/#rt/4156973506415251468

1. Ocean Acidification at the Palau International Coral Reef Center (PICRC)

Ms. Evelyn Ikelau Otto, Palau International Coral Reef Center, Palau
Language: English

This presentation will discuss some of the work that is going on at PICRC in regards to climate change, specifically Ocean Acidification. It will highlight the exciting work that has been conducted in Palau and at the Center as well as highlight some setbacks that were experienced as PICRC develops their OA and water quality monitoring programs.

2. Blue Carbon Restoration and Ocean Acidification in Fiji: A Case Study From Viti Levu Bay

Ms. Miriama Vuiyasawa, University of the South Pacific, Fiji
Language: English

Co-authors: Dr. Katy Soapi (Secretariat of the Pacific Community, Fiji), Joape Ginigini (University of the South Pacific, Fiji), Paayal Kumar (University of the South Pacific, Fiji)

Blue Carbon ecosystems such as mangrove forests and seagrass meadows have the ability to sequester carbon dioxide and store fixed carbon. As a result of this sequestration, there is less dissolved carbon dioxide available in the ocean water column to form acidic compounds. Therefore, restoring blue carbon habitats can help mitigate the effects of ocean acidification (OA) on coastal communities. In 2018 the Institute of Applied Sciences at the University of the South Pacific was awarded a 2-year project to pilot the use of blue carbon in local mitigation of OA in Fiji. The main objective was to increase coastal

resilience through climate change mitigation and better understanding of the role of blue carbon in OA mitigation through support of an existing coastal restoration project. The project was conducted in 4 villages in Viti Levu Bay, Fiji Islands and activities involved mangrove forest restoration, monitoring ocean acidification, raising awareness about observations of ecosystem health at the restored site. The work also provided capacity building for local scientists and early career junior staff on OA monitoring. Discrete water samples were collected at all four sites on a monthly basis and chemical analyses were conducted using protocols from the GOA-ON and an In a Box equipment kit donated by the Ocean Foundation. Data collected includes pH, total alkalinity, salinity and water temperate from which other OA parameters were determined. Along with OA monitoring, a total of 0.7925 ha of mangrove forest (more than (6000 seedlings) was planted with the assistance of the local Navuniivi community. Long term monitoring and more restorative work is needed at the project sites to fully understand and assess the benefits of the restorative efforts and its potential mitigation of OA. Several challenges were encountered, particularly with equipment breakdown and maintenance, and the limited resources to perform monitoring work. Despite these challenges, the project successfully collected OA monitoring data, which was the first dataset for the area and thus contributed to SDG 14 goal for Fiji. The mangrove restorative work was also a huge achievement with great community buy-in that resulted in a successful community collaborative project.

3. Responses of Caulerpa With and Without CO_2 Concentrating Mechanisms to Elevated Ocean Acidification

Ms. Aleluia Taise, Victoria University of Wellington, New Zealand
Language: English

Co-authors: Erik Krieger (Victoria University of Wellington, New Zealand), Sarah Bury (National Institute of Water & Atmospheric Research, New Zealand), Christopher E. Cornwall (Victoria University of Wellington, New Zealand)

Caulerpa is a widely distributed genus of chlorophytes. They are important for their dietary, social, and coastal ecosystem values. Caulerpa is one of the rare few genera that have species both with and without CO_2 concentrating mechanisms (CCMs) that allow active uptake of HCO3-. Two of the most common Caulerpa species in New Zealand, *C. brownii* and *C. geminata*, could have vastly different responses to ocean acidification (OA). This is because of their divergent dissolved inorganic carbon (DIC) uptake. *C. geminata* possesses a CCM while *C. brownii* does not have a CCM. We investigated growth, photo-physiology and DIC utilization responses by *C. brownii* and *C. geminata* at four mean seawater pH treatments (8.03, 7.93, 7.83 and 7.63). In all cases, mean and variability in growth rates of *C. brownii* increased under OA scenarios, while growth rates for *C. geminata* declined under OA. This concurs with predictions that non-CCM species will be gaining benefits from additional CO_2, while species with a CCM may gain less benefits from additional CO_2, while at the same time demonstrating that DIC use alone does not predict responses to OA. We show divergent responses of two Caulerpa species that could have implications for their future abundance in Australasia.

4. Current Status of OA Research in Samoa

Dr. Patila Malua Amosa, National University of Samoa, Samoa
Language: English

Co-authors: Aleluia Taise (National University of Samoa, Samoa), Asonei Leauga (National University of Samoa, Samoa), Varea Vaurasi (National University of Samoa, Samoa), Sekotilani Aloi (National University of Samoa, Samoa), Faainu Latu (National University of Samoa, Samoa), Jeffery Leung Wai (United Nations Development Programme)

The initial OA research in Samoa was implemented with assistance from The Ocean Foundation through the toolkit provided to collect seawater chemistry data. The project faced several challenges during the two years of implementation which was discussed during the 2020 OA week. This presentation will focus on where we are with OA research since then, the impacts of the COVID19 pandemic on our proposed work and the way forward for local OA studies.

Thursday, 16 September 2021

From source to synthesis – improving flow of ocean carbon data

Thursday, September 16 at 12:30 CEST (UTC+2) *View in various time zones*
Register here: https://attendee.gotowebinar.com/register/3815511374429050379

Discussion Leaders:
Dr. Helen Findlay, Plymouth Marine Laboratory, UK
Ms. Kirsten Isensee, Intergovernmental Oceanographic Commission of UNESCO, France
Mr. Benjamin Pfeil, University of Bergen, Norway
Dr. Katherina Schoo, Intergovernmental Oceanographic Commission of UNESCO, France

Abstract: As data generating scientists, we have to find suitable data archives that are coherent with legal obligations of funders and that make it practical for access and visibility. In addition, data should be fit for purpose for synthesis products/reports in order to achieve greatest impact. The ocean acidification data landscape is a complex mix of data repositories, with varying audiences, purposes, meta and data requirements, as well as quality classifications and control mechanisms. Key to facilitating ocean acidification relevant data flow is communication among data producers, data managers and data users, addressing challenges and bringing together the community to find the best solutions. This discussion session of the OA week aims to continue ongoing and initiate new discussions around the following topics:

1. What are the current obstacles/challenges with respect to ocean acidification data flow in your region, your field of research?
2. Who should be taking part in ocean acidification data flow discussions - identification of main stakeholders? How can we improve data flow to meet the commitments for UN SDG 14.3.1, requirements of the funders and the wider benefits for our science and stakeholders that this unique opportunity brings in giving everyone access to datasets of known quality?

Northeast Atlantic Hub Session

Thursday, September 16 at 13:00 BST (UTC+1) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/7816359309889132557

1. Simplification of Marine Ecosystems Under Ocean Acidification

Dr. Ben Harvey, Shimoda Marine Research Center, University of Tsukuba, Japan
Language: English

Co-authors: Sylvain Agostini (Shimoda Marine Research Center, Japan), Shigeki Wada (Shimoda Marine Research Center, Japan), Marco Milazzo (University of Palermo / Consorzio Nazionale Interuniversitario per le Scienze del Mare, Italy), Jason M. Hall-Spencer (Shimoda Marine Research Center, Japan / University of Plymouth, UK), members of International CO_2 & Natural Analogues Network (ICONA)

Human activities are rapidly changing the structure of coastal marine ecosystems, but the ecological consequences of these changes remain uncertain. Natural analogues of futuristic conditions are increasingly being used to assess the likely effects of rising atmospheric CO_2 emissions on marine ecosystems. Here, using a CO_2 seep in Japan, we show how ocean acidification causes habitat and biodiversity loss, resulting in the simplification of marine ecosystems. This simplification involves structurally complex habitat-forming species (including corals and larger macrophytes) being replaced by more homogenous and simple turf algal habitats. Such ecological shifts are concerning because they result in habitats that have less ecological and human value. Moreover, once these ecological shifts occur, OA-driven stabilising feedback loops 'lock-in' these novel turf systems making them particularly

difficult to reverse. By understanding the ecological processes responsible for driving community shifts, we can better assess how communities and ecosystems are likely to be altered by ocean acidification. Taken together, we demonstrate how the simplification of marine habitats by increased CO_2 levels will cascade through the ecosystem and will have severe consequences for the provision of goods and services.

2. Relevant OA Research for Science and Society

Dr. Richard Bellerby, Norwegian Institute for Water Research, Norway
Language: English

Co-authors: Philip Wallhead (Norwegian Institute for Water Research, Norway), Halvor Dannevig (Western Norway Research Institute, Norway), Grete K. Hovelsrud (Nord University, Norway), Aase Kristine Lundberg (Nordland Research Institute, Norway), Evgeniy Yakushev (Norwegian Institute for Water Research, Norway), Kyrre Groven (Western Norway Research Institute, Norway), Hector Andrade (Akvaplan-niva, Norway)

An understanding of the present state, variability and projections of coastal OA is necessary to facilitate appropriate management and investment strategies. This is in line with the Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. One target for this goal is 14.3 stipulating the need to minimise and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels. Despite the challenges to ecosystems and ecosystem services expected from OA, measures to adapt to OA are still hard to come by. While OA is mentioned as an issue in regional management plans and in white- and green papers, for instance regional climate plans in Norway, there are few examples of concrete measures. This presentation reports on a study of OA in coastal Norway where stakeholders had critical roles in scientific design, sampling and data interpretation. The study confirmed that ocean acidification thresholds are already experienced in Norwegian coastal systems and will be a growing challenge. The projected timing for when critical thresholds will be crossed is locally site, depth and service dependent. The project´s co-design and the co-production of new knowledge on coastal OA were essential to deliver targeted, relevant and comprehensible scientific products for coastal users, regulators and industry.

3. Carbonate Chemistry and Calcifying Plankton in Scottish Coastal Waters

Dr. Pablo León Díaz, Marine Scotland Science, UK
Language: English

Co-authors: Pablo León Díaz (Marine Scotland Science, UK), Eileen Bresnan (Marine Scotland Science, UK), Pamela Walsham (Marine Scotland Science, UK), Hannah Holah (Marine Scotland Science, UK), Margarita Machairopoulou (Marine Scotland Science, UK), Susan E. Harman (National Oceanography Centre, UK), Jennifer Hindson (Marine Scotland Science, UK), Kevin Mackenzie (University of Aberdeen, UK), Lynda Webster (Marine Scotland Science, UK)

Ocean acidification (OA) is likely to have a significant impact on calcifying plankton. This group plays a key role in the ocean food webs and global biogeochemical cycles and includes larvae of species of commercial importance for aquaculture and fishery industries (e.g. bivalves). However, field studies on carbonate chemistry and calcifying plankton are scarce. Operated by Marine Scotland Science, the Scottish Coastal Observatory (SCObs; http://dx.doi.org/10.7489/1881-1) monitoring site at Stonehaven is providing baseline information about the seasonality and interannual variability of carbonate chemistry as well as the plankton community in Scottish waters. Three years of monthly samples were analysed using Scanning Electron Microscopy (SEM) to investigate the relationship between carbonate chemistry parameters and calcifying groups at Stonehaven, including coccolithophores, pelagic gastropods and the planktonic larvae of benthic bivalve species. SEM analyses revealed evidence of shell dissolution in all analysed species during the study period despite the seawater being supersaturated with respect to aragonite, with the most severe damaged observed during periods of decreasing aragonite saturation. These results suggest that seasonal and short-term changes in carbonate chemistry might affect the shell integrity of plankton calcifiers, also indicating that dissolution may appear under higher saturation values

than previously assumed. This work also highlights the value of sustained observations to distinguish OA changes from natural variability and to assess the potential impacts of OA on marine ecosystems.

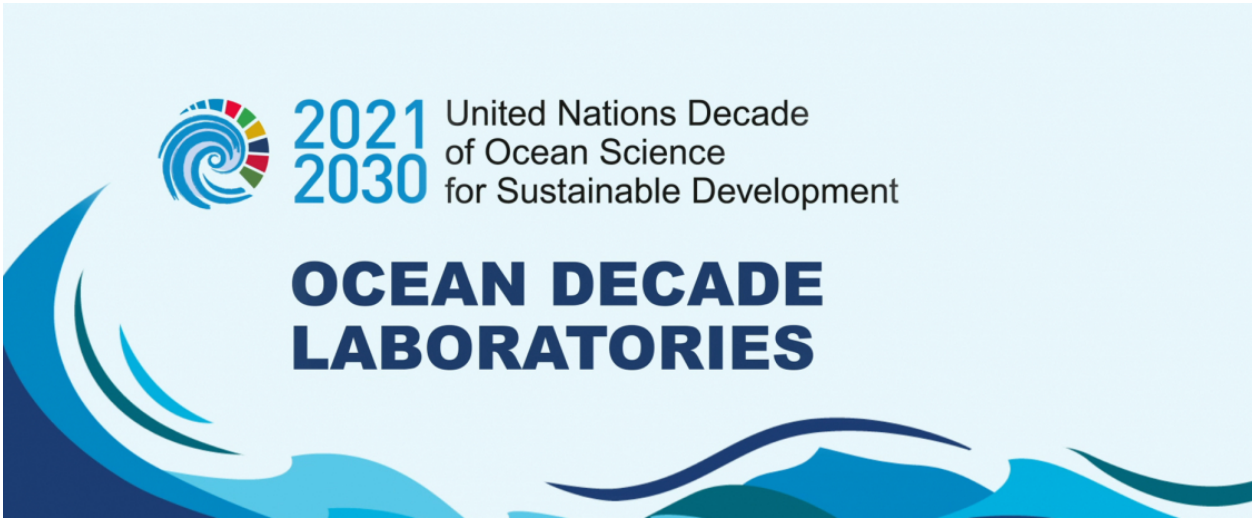
Photo credit: Ellen Cuylaerts

Ocean Acidification Research for Sustainability (OARS) Overview and Community Discussion

Thursday, September 16 at 15:00 BST (UTC+1) *View in various time zones*
Register here: https://register.gotowebinar.com/register/6510815695585284879

Discussion Leaders:
Dr. Jan Newton, University of Washington, USA
Dr. Steve Widdicombe, Plymouth Marine Laboratory, UK

Abstract: In the summer of 2021, the UN Decade of Ocean Science formally endorsed GOA-ON's proposed programme "Ocean Acidification Research for Sustainability", also known as OARS. This programme aims to provide society with the observational and scientific evidence needed to sustainably identify, monitor, mitigate and adapt to ocean acidification, from local to global scales. The objective of this community discussion today is to receive input from the global ocean acidification community as to what support is required and how GOA-ON can best enhance ocean acidification observation and research capacity, taking into consideration local and regional specificities. We invite you to engage in the discussion to identify strategies and partners, supporting OARS and GOA-ON, to increase capacity in OA monitoring and research efforts within your respective regions, countries, and institutions. We hope to gather insights on which particular aspects of OARS could be expanded or improved upon in order to achieve the UN Decade Action outcomes.



A Community Discussion Around CO_2-in-Seawater Certified Reference Materials (CRMs)

Thursday, September 16 at 09:00 PDT (UTC-7) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/3386169675703327757

Discussion Leaders:
Dr. Michael Acquafredda, Ms. Courtney Cochran, Dr. Shallin Busch, & Dr. Libby Jewett, NOAA, USA
Dr. Regina Easley, National Institute of Standards and Technology (NIST), USA
Dr. Andrew Dickson, Scripps Institution of Oceanography, USA
Dr. Maribel Garcia Ibanez, University of East Anglia, UK
Dr. Maciej Telszewski, International Ocean Carbon Coordination Project (IOCCP), Poland
Dr. Peter Swarzenski, & Ms. Ashley Bantelman, International Atomic Energy Agency OA-ICC, Monaco
Dr. Tobias Steinhoff, Dr. Elaine McDonagh, & Dr. Richard Sanders, Norwegian Research Center (NORCE), Norway
Dr. Kim Currie, National Institute of Water and Atmospheric Research (NIWA), New Zealand

Abstract: Reference materials (RMs) are fundamental for accurate and precise measurements of seawater CO_2 system parameters and research related to ocean acidification and oceanic carbon cycles. Currently, there is a single source of RMs for total alkalinity, dissolved inorganic carbon, and pH in seawater and a calibrated HCl titrant for seawater alkalinity analysis (Dickson Laboratory, Scripps Institution of Oceanography). However, the US Interagency Working Group on Ocean Acidification (US IWG-OA) and various international organizations are working to increase the resilience of production and distribution of CO_2-in-seawater RMs. In this community discussion session, participants will receive status updates from American & European. Additionally, the US IWG-OA will share its findings from the "CO_2-in-seawater Reference Materials Community Survey" that was distributed earlier this year. There will be an extended Question & Answer panel discussion, and audience members will be given ample time to ask questions and share their thoughts.

Photo credit: Mike Bartick

OA Social Vulnerability Assessments Community Discussion

Thursday, September 16 at 16:00 EDT (UTC-4) *View in various time zones*
Register here: https://register.gotowebinar.com/rt/5293352858468281616

Discussion Leaders:
Ms. Courtney Cochran, NOAA OAP, USA
Ms. Jessie Turner, International Alliance to Combat Ocean Acidification, USA
Ms. Darcy Dugan, Alaska Ocean Observation System / Alaska OA Network, USA
Dr. Jan Newton & Dr. Melissa Poe, University of Washington, USA

Abstract: Ocean acidification is expected to threaten many marine resources that human communities rely on for food security, livelihoods, and cultural value. While knowing the vulnerability of different communities can help inform where management actions are needed, understanding social vulnerability to ocean acidification remains a challenge. This session will highlight ongoing efforts to address vulnerability in the US and lead to discussions about how other regions can start to think about assessing local vulnerability to OA. The US Interagency Working Group on Ocean Acidification (US IWG-OA) will share updates on a new report that will characterize ecological and social vulnerability to ocean acidification on a global scale. Participants will also hear from panelists in the U.S. who have worked on regional vulnerability assessments or directly with stakeholders, with a focus on how to take first steps and overcome challenges such as data limitations. A large portion of the session will be dedicated to a Question & Answer session with the panel, and audience members will be encouraged to think about how social vulnerability could be addressed in their own region.

Photo credit: Kimberly Jeffries

Friday, 17 September 2021

IOC-WESTPAC (Western Pacific) May Webinar Series (re-broadcasting)

Friday, September 17 at 18:00 CST/MYT (UTC+12) *View in various time zones*
Register here: https://attendee.gotowebinar.com/register/6063171526721392651

1. Underway Measurement of Dissolved Inorganic Carbon (DIC) in Estuarine Waters
Dr. Liyang Zhan, Third Institute of Oceanography, China
Language: English

2. Effects of Ocean Acidification on Oyster Aquaculture
Professor Aileen Tan Shau Hwai, Universiti Sains Malaysia, Malaysia
Language: English

3. Coral reefs and ocean acidification: impacts and adaptive capacity in Thailand and southeast Asia
Dr. Suchana Chavanich, Chulalongkkorn University, Thailand
Language: English

Photo credit: Grant Thomas

Plenary #4: OceanSODA

Friday, September 17 at 13:00 BST (UTC+1) *View in various time zones*
Register here: https://attendee.gotowebinar.com/rt/4536528218876450830

The Satellite Oceanographic Datasets for Acidification (OceanSODA) Project
Dr. Nicolas Gruber, Professor of Environmental Physics, Eidgenössische Technische Hochschule (ETH Zürich), Switzerland
Ms. Hannah Green, University of Exeter, UK
Dr. Jamie Shutler, Associate Professor in Earth Observation, University of Exeter, UK

The potential of satellite observed salinity for observing the surface water carbonate system was identified some time ago and this space-based capability, combined with established temperature observations from space, is now enabling the development of novel satellite observation-driven acidification and inorganic carbon assessments (e.g., Land et al., 2019; Gregor and Gruber, 2021; Green et al., 2021; Quilfen et al., 2021). The European Space Agency funded Satellite Oceanographic Datasets for Acidification project (OceanSODA) aimed to establish the role that satellite-based Earth Observations can play in supporting and expanding research and monitoring in ocean acidification. The project, now nearly complete, had two distinct foci, scientific advancement and downstream impact assessments. The scientific advancements have produced regional and global time-series data of the surface water carbonate conditions with well characterised accuracies. The downstream assessments included the characterization and analysis of how upwelling (of low pH waters), compound (heatwaves and high acidity) events, and large river outflows (of low pH waters) impact the carbonate system, and how these conditions could affect marine organisms and ecosystems. The project has also identified how satellite observations can be used for, and are critical for, observing Arctic carbonate system conditions. These capabilities and datasets are now beginning to be noticed by non-scientific user groups as they hold potential for guiding management and policy decisions. This plenary session will discuss how this work has evolved, highlighting the scientific advances, identify potential new scientific opportunities, and discuss how these capabilities are now being noticed by early adopters and stakeholders to support decision making, by considering a range of users from shellfish farmers through to regional resources managers advising US and Canadian state governors.

Plenary #5: Attribution and Blue Carbon

Friday, September 17 at 17:00 East Africa Time (UTC+3) *View in various time zones*
Register here: https://attendee.gotowebinar.com/rt/7188437015374585870

1. Detection, Attribution & Predictability of Ocean Acidification

Dr. Scott Doney, Joe D. and Helen J. Kington Professor in Environmental Change, University of Virginia, USA

Uptake of anthropogenic carbon dioxide from the atmosphere by the surface ocean is leading to global ocean acidification, but regional variations in ocean circulation and mixing can dampen or accelerate apparent acidification rates. Excess nutrient pollution can also result in coastal acidification in estuaries and near shore regions. Both climate variability and nutrient pollution exacerbate the ecological press from rising atmosphere CO_2 and can cause extreme acidification events that are detrimental to ecosystem health and fisheries.

2. Seagrasses in warming and acidifying oceans: physiological responses

Dr. Rushingisha George, Tanzania Fisheries Research Institute (TAFIRI), Tanzania

As concentration of anthropogenic CO_2 continues to increase in the atmosphere, both ocean warming and acidification will continue to increase globally. This can have both negative and positive impacts on the health and function of seagrasses, which are key primary producers and ecosystem engineers in the coastal zone. The key physiological processes (photosynthesis, calcification and respiration) of these plants operate over a wide range of climatic factors (temperature, CO_2, dissolved oxygen etc.) and their response can serve to mitigate the impacts of ocean acidification on short-time scales. This talk will focus on the responses of seagrass physiological processes to elevated climatic factors (under both current and future conditions) in the water column, and how these responses affect the pH of the water column as well as on the effect of the tidal variability on pH of seagrass meadows and adjacent coastal habitats. Research findings show that seagrass physiological processes respond differently to elevated climatic factors and their interaction govern the pH of the system. The effect of physiological processes on pH of seagrass meadows of intertidal waters depend on the water level and percentage cover, and is highest during low spring tides. Photosynthetic uptake of dissolved inorganic carbon (DIC) can raise the mean pH of seagrass meadows, and adjacent mangrove and coral reef habitats to 5% above that of adjacent open ocean during daytime at high tide. These findings show that healthy seagrass meadows offer a

huge potential to mitigate the impacts of ocean acidification, as their photosynthetic uptake of DIC have been shown raise the mean pH of seagrass meadows, and adjacent mangrove and coral reef habitats to 5% above that of adjacent open ocean during daytime at high tide. Therefore, reducing anthropogenic stressors such as eutrophication by land-based pollution sources, among others, will make seagrass meadows healthy and resilient to elevated water temperatures while mitigating the impacts of ocean acidification on temporal scales.

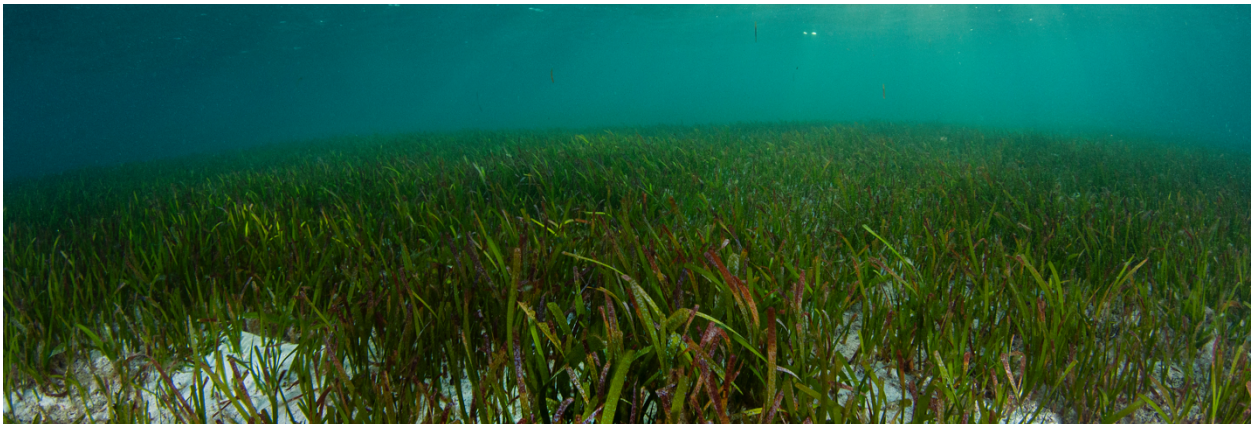


Photo credit: Umeed Mistry

REMARCO regional observatory takes up the challenge: reporting marine acidity in Latin America and the Caribbean

Friday, September 17 at 18:00 Central European Standard Time (UTC+2) *View in various time zones*
Register here: https://attendee.gotowebinar.com/register/3318998311620244496

Discussion Leader:
Cesar Bernal, Jefe Unidad de Laboratorios de Calidad Ambiental Marina – LABCAM, Colombia

Abstract: The Marine-Coastal Stressors Research Network in Latin America and the Caribbean (REMARCO) is made up of institutions from 18 Latin American and Caribbean countries, participating in the International Atomic Energy Agency (IAEA) technical cooperation project RLA/7/025 for the strengthening of coastal marine research. The project currently includes research on aspects of harmful algal blooms, eutrophication, microplastics and ocean acidification with the aim of communicating with the different actors and generating tools for decision-makers. The main objective of the acidification component is to build capacity in the region to measure ocean acidity and report on Sustainable Development Goal (SDG) indicator 14.3.1 (pH). To achieve this objective, the following activities are being carried out:

- Forming a working team with researchers from the 18 REMARCO countries.
- Identify the needs in the region that to date did not allow the indicator to be reported and a REMARCO plan to close the gaps.
- Establish agreements between those responsible for national reporting of the indicator and REMARCO.
- Establish a regional observatory to generate local and regional data of global interest.
- Develop standardized protocols for sampling, measurement and uncertainty estimation of total alkalinity, pH_T and dissolved inorganic carbon.
- Conduct (virtual) training courses for analysts and indicator reporters.
- Deliver kits of equipment, materials and reagents for indicator reporting with the required quality.
- Strengthen regional capacities to purify m-cresol and develop working standards.
- Report indicator 14.3.1 (3 countries by 2020).

A "round table" will be held with representatives of the ocean acidification component from different REMARCO countries (Spanish, English and Portuguese languages) and a representative of IAEA. The representatives will make 5 min interventions and after each presentation a question and answer session will be opened for discussion with the audience (each question will be answered in the language in which the question is generated).

Photo credit: Ocean Image Bank

GOA-ON Global Ocean Acidification Observing Network

*CREDIT: **5th International Symposium on the Ocean in a High-CO2 World:** W. Carbajal, F. Vílchez & J. Macalupú*

All sessions will be recorded and archived on the GOA-ON Youtube Channel.

More details about Ocean Acidification Week can be found on the OA Week 2021 webpage.

You can also stay up-to-date by following GOA-ON on Twitter and Facebook!