GOA-ON
Global Ocean Acidification Observing Network

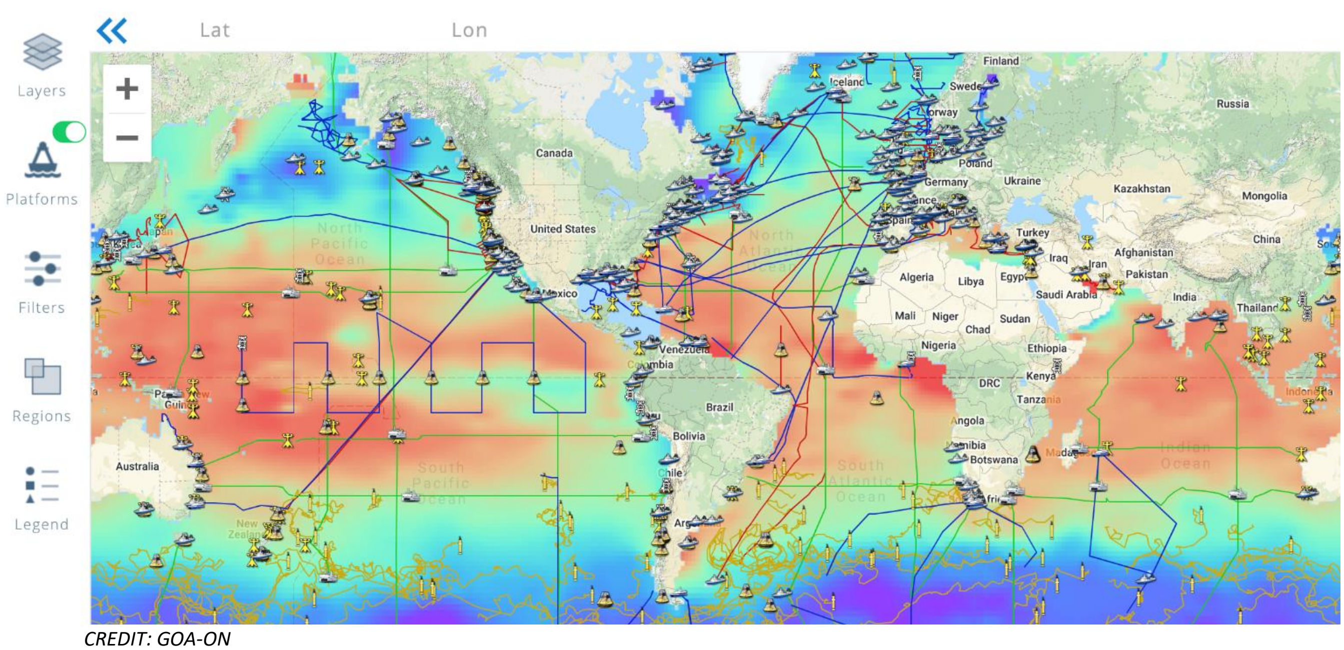
NOAA IAEA | Ocean Acidification International Coordination Centre OA-ICC | UNESCO United Nations Educational, Scientific and Cultural Organization | Intergovernmental Oceanographic Commission

Ocean Acidification Week

A virtual multi-day forum to highlight ocean acidification research and initiatives

8-10 September 2020

#OAWeek2020



CREDIT: GOA-ON

Tuesday, 8 September 2020

Session 1 — Pacific Islands and Territories OA Hub

02:00 Greenwich Mean Time (UTC) = 14:00 New Zealand Standard Time (UTC +12)

Pre-register here: http://bit.ly/PI-TOA

1. "An overview of PPOA and the PI-TOA Hub"

Duncan McIntosh
Secretariat of the Pacific Regional Environment Programme (SPREP), Samoa

The Pacific Partnership on Ocean Acidification (PPOA) project, implemented by SPREP and funded by the New Zealand Ministry of Foreign Affairs and Trade and the government of the Principality of Monaco, is working to build resilience to ocean acidification in Pacific island communities and ecosystems through;
- Research and monitoring
- Capacity building and awareness raising
- Policy support
- Practical adaptation actions

2. "Expansion of ocean acidification monitoring in Aotearoa New Zealand with the addition of 9 MPA sites to the NZOA-ON"

Kim Currie[1] & Monique Ladds[2]
[1]National Institute of Water and Atmospheric Research (NIWA), New Zealand;
[2]Department of Conservation, New Zealand

Understanding the effects of ocean acidification is vital to making informed conservation management decisions for our marine protected areas (MPAs). The New Zealand Department of Conservation (Te Papa Atawhai) is joining the New Zealand Ocean Acidification Observing Network, by initiating OA monitoring in 9 MPAs, encompassing a wide range of ecosystem types and utilizing community science.

3. "Monitoring Ocean Acidification and anthropic impacts on net productivity of Suva Reef, Fiji"

Antoine de Ramon N'Yeurt
The University of the South Pacific, Pacific Centre for Environment and Sustainable Development, Fiji

In the context of a broader study on anthropic impacts from river discharge into the Suva Lagoon and Reef, both continuous OA time series using autonomous data loggers and discrete TA samples of the water column are being carried out to assess the carbon budget of reef communities and inform ecosystem-based management of the area.

4. "Ocean Acidification Monitoring in Vanuatu"

Krishna Kotra
The University of the South Pacific, Vanuatu

Ocean Acidification monitoring in Vanuatu was introduced in 2018. The journey so far achieved mixed results but the program is still underway with pH and alkalinity data collection. In all the aim for introduction, awareness, stakeholder participation and data collection was largely achieved and hope would continue as well.

5. "Challenges of conducting Ocean Acidification research in Samoa"

Patila Malua Amosa* & Jeffery Leung Wai
National University of Samoa, Samoa

The Samoa research team implemented an OA project in collaboration with TOF. Although the research started off well, it faced some challenged which impacted the progress of the project.

6. "Adaptive and Restoration Approaches for Resilient Kiribati toward Ocean Acidification"

Manibua Rota*, Max Peter, Tooreka Teemari & Karibanang Tamuera
Ministry of Fisheries & Marine Resource Development (MFMRD), Kiribati

CREDIT: NOAA/XL Catlin Seaview Survey

Session 2 — Mediterranean OA Hub

10:00 Greenwich Mean Time (UTC) = 12:00 noon Central European Summer Time (UTC +2)

Pre-register here: http://bit.ly/OAMedHub

1. "Overview of OA research in the Mediterranean and knowledge gaps"

Patrizia Ziveri
Universitat Autònoma de Barcelona-Institute of Environmental Science & Technology (ICTA-UAB); Catalan Institution for Research and Advanced Studies (ICREA), Spain

State of Knowledge on Ocean Acidification in the Mediterranean Sea
-This meta-analysis compiled the OA research carried out on Mediterranean with a focus on research performed after 2014 (the completion of the European coordinated project Mediterranean Sea acidification in a changing climate (MedSeA).
-In the Mediterranean Sea, OA research is heavily concentrated in Western European nations but this is becoming more dispersed with time.
-Although a more comprehensive understanding of how OA is changing the chemistry of the Mediterranean is now available, knowledge of the complex biological consequences for endemic ecosystems is limited and the broader socio-economic impacts of OA for Mediterranean-dependent societies are poorly explored.

2. "Evolution and Adaptation of Coccolithophores towards recent environmental changes in the Mediterranean"

Majd Habib
CNRS-L, National Center for Marine Sciences, Lebanon;
CEREGE-CNRS, Université Aix-Marseille, France

In Lebanon-Eastern Mediterranean Sea, no studies have been conducted yet to quantify coccolithophores populations and assess their relationships with environmental drives. Therefore, preliminary results related to the coccolithophores assessment and thickness in the context of ocean acidification will be presented.

3. "Towards a public and internally consistent data product containing CARbon, transient tracers and ancillary data In the MEDiterranean Sea, CARIMED"

Marta Álvarez
Instituto Español de Oceanografía, Spain

A total of 46 cruises (1979-2018) covering the whole Mediterranean Sea were assembled, formatted and quality controlled for ancillary (temperature and salinity, and dissolved oxygen and inorganic nutrients) along with CO_2 and transient tracer data. This database aims to be internally consistent without removing any temporal evolution and publicly available.

4. “The drivers of pH and CO_2 variability in the Adriatic”

Lidia Urbini & Michele Giani
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy

We present the spatial distribution and temporal variability of the carbonate system in the Adriatic Sea based on both discrete samplings and continuous measurements performed in two oceanographic stations, which are part of the Global Ocean Acidification Observational Network (GOA-ON) and of the Integrated Carbon Observing Systems (ICOS). This permits us to better understand the effects of the principal drivers like changes in temperature, in air-sea interactions, in riverine inputs and in biological processes.

5. “The influence of marine vegetation in coastal CO_2 dynamics”

Iris Hendriks
Instituto Mediterráneo de Estudios Avanzados (IMEDEA - CSIC-UIB), Spain

6. “Impact of ocean acidification on Mediterranean sea Blue Economy”

Nayrah Shaltout
National Institute of Oceanography and Fisheries, Egypt

CREDIT: Jason Hall-Spencer

Session 3 — North American Hub

19:00 Greenwich Mean Time (UTC) = 12:00 Pacific Daylight Time (UTC -7)

Pre-register here: http://bit.ly/NA_OAHub

1. "Insights from marine CO2 time series along the British Columbia coast of Canada"

Wiley Evans
Hakai Institute, Canada

Modeling efforts and observational records are producing information on marine CO2 patterns over a range of time and space scales along the British Columbia coast. This talk will highlight some of these efforts and insights they have produced.

2. "Oh dear! Oh dear! I shall be too late! A story of timing, biodiversity and global change"

Piero Calosi
Université du Québec à Rimouski, Canada

3. "Status of Ocean Acidification in Mexico: Gulf of Mexico"

Jose Martin Hernandez Ayon
Universidad Autónoma de Baja California (UABC), Mexico

4. "Status of Ocean Acidification in Mexico: Pacific Coast"

Cecilia Chapa
Universidad del Mar (UMAR), Mexico

We present an overview of the OA studies that have been carried out in the Mexican Pacific, the main results and challenges. The mexican part of the California Current System is the most studied region while the tropical region is undersampled. There is lack of data inmost regions, while some are still generating baseline information about the carbonate system and its variability, to be able to detect the progression of OA in the future. Studied regions include the continenta shelf, coral reefs and coastal lagoons.

5. "Developing best practices for determining multi-decadal change in ocean acidification time series"

Adrienne Sutton
National Oceanic & Atmospheric Administration, Pacific Marine Environmental Laboratory (NOAA, PMEL), USA

Time-series observations are one of the most valuable tools for characterizing how the ocean carbon system is changing over time. While observing methods are standardized across a distributed network of investigators, a common set of approaches for analysing data to identify trends is not. This presentation will focus on results from a workshop in February 2020 that started to develop best practices for determining multi-decadal change in biogeochemical time series and assessing anthropogenic trends.

6. "Where chemical and biological observations meet: Insights into anthropogenic impacts on the current biological status"

Nina Bednarsek
Southern California Coastal Water Research Program (SCCWRP), USA

Integrative efforts along the US West coast of combining physical-chemical observations with the biological sampling and experiments, as well as biogeochemical modelling, provide the insights into the current state of ocean acidification impacts on marine calcifiers, such as ecologically important pteropods and economically important Dungeness crab, and specifically delineate the extent of the anthropogenic CO2 ocean uptake exacerbating negative biological effects.

CREDIT: Hakai Institute: Grant Callegari, Jonathan Kellogg, Keith Holmes

Wednesday, 9 September 2020

Session 4 — Arctic Hub

10:00 Greenwich Mean Time (UTC) = 12:00 noon Central European Summer Time (UTC +2)

Pre-register here: http://bit.ly/ArcticHub

1. "Introduction, kick-off, and overview of the Arctic Hub"

Agneta Fransson*[,1,2], Melissa Chierici[2,3], Kumiko-Azetsu Scott[4] & Jessica Cross[5]
[1]Norwegian Polar Institute, Fram Centre, Norway; [2]University Centre in Svalbard (UNIS), Norway; [3]Institute of Marine Research, Fram Centre, Norway; [4]Bedford Institute of Oceanography, Canada; [5]National Oceanic & Atmospheric Administration, Pacific Marine Environmental Laboratory (NOAA, PMEL), USA

Overview of Arctic ocean acidification research and introduction to Arctic hub. We will give an overview of the ocean acidification monitoring and research in the Arctic Ocean. The new Arctic hub will be introduced (kick-off) and the direction of the Arctic hub research will be discussed

2. "Highlights from 9-years of monitoring Ocean Acidification in Norwegian and Arctic waters"

Melissa Chierici*[,1,2], Elizabeth Jones[1], Ingunn Skjelvan[3], Kai Sørensen[4], Andrew Luke King[4], Marit Norli[4], Helene H Lødemel[1], Claire Mourgues[1], Siv Lauvset[3], Tina Kutti[5], Knut Yngve Børsheim[5], Kristin Jackson[6], Tor de Lange[6] & Agneta Fransson[2,7]
[1]Institute of Marine Research, Fram Centre, Norway; [2]University Centre in Svalbard (UNIS), Norway;
[3]NORCE Norwegian Research Centre (NORCE), Norway;
[4]Norsk institutt for vannforskning (NIVA), Norway; [5]Institute of Marine Research, Norway;
[6]University in Bergen, Norway; [7]Norwegian Polar Institute, Fram Centre, Norway

In 2011, a multi-institutional monitoring program for ocean acidification in Norwegian waters, from the Skagerrak and North Sea in the south, to the northern Barents Sea in the north was funded by the Norwegian Environment Agency. Additional observations from the waters around Svalbard and the eastern Fram Strait are presented and discussed. The observational programs encompass measurements of carbonate chemistry and ancillary variables such as salinity, temperature, and inorganic nutrient concentrations to provide baseline observations and information on the spatial and temporal variability. We use a combination of sampling platforms such as water column measurements along repeated transects from the coast to open ocean and underway measurements of surface-water carbonate system measurements for seasonal studies. One of the aims of the repeated surveys is to investigate the trends in pH, which has been observed to decrease at a faster rate than the global mean pH decrease rate, most likely due to the influence of anthropogenic CO_2. The observations in the Barents Sea show lowest pH and aragonite saturation in the polar surface water and in the bottom water, but no clear trends are discerned between 2011 and 2019. The aragonite dissolution horizon is located at about 2000 m in the Norwegian Sea. The observed variability is attributed to oceanographic and anthropogenic processes, such as the influence of mixing of water masses, freshwater/meltwater inputs, oceanic CO_2 uptake, and biological production and respiration. The inflow waters to the Arctic show little change with regard to pH and calcium carbonate ($CaCO_3$) saturation. The Svalbard fjords show large interannual and seasonal variability and additional data is required to determine trends. The data provide information that are used in model projections of future CO_2 emission scenarios and estimates in changes in the depth of the $CaCO_3$ saturation horizon. However, to determine the individual drivers of ocean acidification and their regional, seasonal and interannual variability, integrated monitoring including measurements or proxies for biological productivity, ocean physics, and land-ocean exchanges, in both surface water and in the water column is essential.

3. “Modelling ocean acidification in a rapidly changing Arctic ocean”

Eric Mortenson*[1], N. Steiner[2], T. Sou[2] & J. Laenger[3]
[1]Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia; [2]Fisheries and Oceans Canada, Institute of Ocean Sciences, Canada; [3]University of Victoria, Canada

A coupled sea ice-ocean biogeochemistry model with pelagic and sea-ice ecosystem components including carbon cycling is applied for the Arctic. The model has been run over the recent period of Arctic sea-ice loss (1979-2015) and evaluated with respect to ocean and sea-ice changes, ocean acidification and CaCO3 saturation. The model indicates significant regional variability in the Arctic with some regions already perpetually undersaturated with respect to aragonite at the surface. Including the sea-ice carbon pump shows only a small change to the total uptake of carbon but a marked decrease in the seasonal variability of both DIC and TA, as well as an offset in the summertime saturation state in the surface Arctic Ocean. Including sea-ice algae has a cumulative effect on upper water column nutrients and the carbon uptake suggesting that inclusion of the sympagic ecosystem has a growing importance for longer-term model runs.

4. “Biological impact of ocean acidification in the Canadian Arctic: widespread severe pteropod shell dissolution in Amundsen Gulf”

Andrea Niemi
Fisheries and Oceans Canada, Institute of Ocean Sciences, Canada

Limacina helicina shell condition was investigated as a biological indicator of the presence and potential impact of acidified waters in the Canadian Beaufort Sea. In both 2014 and 2017, > 85 % of *L. helicina* assessed from the Amundsen Gulf region displayed shell dissolution and advanced levels of dissolution occurred at all stations. Evidence of shell repair was present in 2014, likely supported by abundant food availability in 2014 relative to 2017. The proportion of damaged *L. helicina* collected from coastal embayments and offshore stations is higher than in other Arctic and temperate locations indicating that exposure to corrosive waters is spatially widespread in the Amundsen Gulf region, and periods of exposure are extreme enough to impact the majority of the population.

CREDIT: Pablo Clemente-Colon

Session 5 — OA Africa Hub

13:00 Greenwich Mean Time (UTC) = 15:00 Central Africa Time (UTC +2)

Pre-register here: http://bit.ly/OAAfricaHub

1. "Ocean Acidification White Paper for East Africa - Observation and Research Needs"

Roshan T. Ramessur
University of Mauritius (Chair OA-East Africa, Faculty of Science), Mauritius

Recently, WIOMSA in partnership with IOC-UNESCO, OA-ICC and GOA-ON supported six projects along the Eastern African Coast to support ocean acidification observation systems in the field, the implementation of the SDG 14.3.1 indicator methodology, the investigation of biological response to ocean acidification using experimental set-ups in the laboratory, or a combination of both. The status and research objectives of this initiative will be highlighted as described in the OA White paper for East Africa.

2. "OA investigations for pH and alkalinity in coastal lagoons in Mauritius"

Kishore Boodhoo* & Roshan T. Ramessur
University of Mauritius, Mauritius

Monitoring aspects including spatial and temporal data collection for pH and alkalinity in coastal lagoons of Mauritius - Spectrophotometric determination of pH, SOP for alkalinity measurements and iSAMI pH Sensor (Sunburst Sensors, LLC) time series measurements under IOC-UNESCO- WIOMSA Project in setting up the Oceanic Carbonate Chemistry Observatory in Mauritius Waters will be discussed.

3. "Ocean acidification research by the Oceanographic Research Institute in South Africa"

David Pearton*[,1], Carla Edworthy[2], Sean Porter[1] & Michael Schleyer[1]
[1]Oceanographic Research Institute, South African Association for Marine Biological Research, South Africa; [2]South African Institute for Aquatic Biodiversity, South Africa

South Africa straddles two oceans and is influenced by both warm and cold oceanic currents. As a result, the coastal zone of South Africa is environmentally and ecologically diverse, covering everything from warm water corals to upwelling-driven cold-water kelp forests. South Africa is therefore a microcosm where a wide range of anthropogenic influences can be studied, including ocean acidification (OA). Research at ORI is concentrating on the potential effects of OA and warming on the high-latitude corals in the iSimangaliso Wetland Park World Heritage Site. A long-term observation site is being established and both in situ and ex situ experiments on the effects of OA on calcifying ecosystems are being carried out. Other researchers from SAIAB in South Africa are monitoring coastal ocean acidification and its potential effects on critical fisheries species in the temperate Eastern Cape.

4. "OA Activities in West Africa"

Abraham Ekperusi
Nigeria Maritime University, Nigeria

There is limited OA science and research in the West African sub-region, but many young reseachers are excited about the prospect of kick-starting OA activities in the sub-region.

5. “From training to data collection – Ocean acidification research in East Africa”

Sam Dupont
University of Gothernburg, Sweden

Since the first training in South Africa in 2015, ocean acidification research developed significantly in East Africa. Recently, 6 countries (Kenya, Mauritius, Mozambique, Tanzania, Seychelles and South Africa) joined forces through a WIOMSA project with the goal to monitor and study the impacts of ocean acidification. This presentation will summarize the current achievements: Several additional training have been organized, a joined strategy and associated methodology have been developed and the first data on biological response collected.

6. “BCSS Ocean Observatory in Mozambique”

Mario Lebrato* & Karen Bowles
Bazaruto Center for Scientific Studies (BCSS), Mozambique

Presentation of the new WIO Ocean Observatory in the Bazaruto Archipelago (BCSS Marine Station) with the first permanent multi-ecosystem time-series work in the region. The observatory is a new platform where OA will be studied, among other processes/issues, in various ecosystems (coral reefs, seagrass, mangroves, sand banks, the open ocean, etc) on time-series mode. The platform offers an opportunity for national and international researchers, students, volunteers, and the public in general to conduct fieldwork, and engage in marine sciences.

CREDIT: Roshan Ramessur

Session 6 — LAOCA (Latin American & Caribbean) Hub

17:00 Greenwich Mean Time (UTC) = 12:00 Peru Time (UTC -5)

Pre-register here: http://bit.ly/LAOCA

1. "LAOCA Network: A regional effort for the coordination and support of ocean acidification research in Latin America"
Cristian Vargas
Universidad de Concepcion, Chile

2. "Ocean acidification in tropical Latin America"
Francisco Navarrete-Mier
EBIOAC - ULEAM University, Ecuador

3. "Ocean acidification in the Southwestern Atlantic Ocean"
Rodrigo Kerr[1] & Carla Berghoff[2]
[1]Instituto de Oceanografia, Universidade Federal do Rio Grande (FURG), Brazil;
[2]Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP), Argentina

4. "Ocean acidification in the Humboldt Current ecosystem"
Wilmer Carbajal Villalta
Universidad Nacional Pedro Ruiz Gallo, Perú

The large marine ecosystem of the Humboldt current (approx. 5 ° - 40 ° S): Peru - Chile, is characterized by its cold waters, the seasonal occurrence of coastal upwellings and El Niño events on an interannual scale, among others. A panoramic view of the advances and gaps in the study of ocean acidification is presented in relation to monitoring, experimentation, impact on calcifying organisms and modeling of the carbonate system parameters, with emphasis on pH, pCO2 and Total Alkalinity, with the objective of looking for answers for the high variability of pH and pCO2 in this ecosystem.

5. "Ocean acidification: knowledge gaps and challenges in the region"
Alberto Acosta
Universidad Javeriana, Colombia

CREDIT: Nelson Lagos

Thursday, 10 September 2020

Session 7 — Northeast Atlantic Hub, Part 1

10:00 Greenwich Mean Time (UTC) = 12:00 noon Central European Summer Time (UTC +2)

Pre-register here: http://bit.ly/NEAhub_Part1

1. “Nordic Seas Acidification”

Filippa Fransner
University of Bergen, Norway

Here we make a deep dive into acidification rates and its drivers in the Nordic Seas. We focus on present trends by using a large set of in-situ measurements sampled between 1980 and 2019, and put it into perspective to pH changes since the preindustrial as well as projected future trends by using gridded climatological data and CMIP5 model simulations. The pH in the Nordic Seas has decreased with 0.11 units the last 40 years, a change that is twice as big as between 1850-1980. The largest trends are found in surface waters, where the main driver of pH change is an increase in dissolved inorganic carbon that is slightly opposed by an increase in alkalinity. We find that present trends are larger than expected from the change in atmospheric CO_2, which is related to an overall decrease in the CO_2-undersaturation of the surface waters. In regions of deep water formation, the acidification signal reaches deeper waters compared to other regions. The acidification has led to a substantial decrease in the saturation states of aragonite, bringing the waters at 1000-2000 meters of depth to the edge of undersaturation. The future saturation state largely depends on the emission scenario, where in the worst-case scenario RCP8.5 the whole water column will be undersaturated with respect to aragonite.

2. “Impact of water masses on OA conditions in canyons along the Irish Shelf edge”

Rachel R Cave
University of Galway, Ireland

The continental shelf edge west of Ireland forms the eastern flank of the Rockall Trough, and is deeply incised by canyons all along its length. These canyons descend from ~400m to full ocean depths of ~ 2500m in this area, and support a wide range of sessile organisms susceptible to increasing ocean acidification, including cold water corals. A number of water masses are routinely observed in the Rockall Trough at different depths, with origins from both north and south. During the VOCAB project, two surveys were carried out specifically targeting canyons in summer of 2018, one in the Southern Rockall Trough to a canyon cluster at 52°N and the other in the northern Rockall Trough targeting 6 canyons between 54 and 56°N. The total shelf-edge distance explored was ~ 650km. These surveys collected both hydrographic and ocean acidification data as well as carrying out ROV surveys for biology. Our results show both the different water masses impinging on the canyons north and south, and how the water masses and their mixing strongly control the OA parameters of water in the canyons. Even in this relatively small area, this may lead to different outcomes for fauna in different canyons in the Rockall Trough as increasing atmospheric CO_2 continues to alter ocean chemistry, and as climate change alters the global ocean circulation.

3. “Monitoring for OA in the Western Channel Observatory and in the Atlantic Ocean”

Helen Findlay & Vas Kittidis
Plymouth Marine Laboratory, UK

Here we describe the 10 year time series in the Western English Channel, detailing the trends and seasonal cycles, and investigating possible near-shore influences on the carbonate system. We then describe the monitoring on the Atlantic Meridonal Transect (AMT) project, highlighting the trends in carbonate chemistry parameters.

4. “Spectrophotometric measurement of [CO_3^{2-}] in seawater: dealing with inconsistencies”

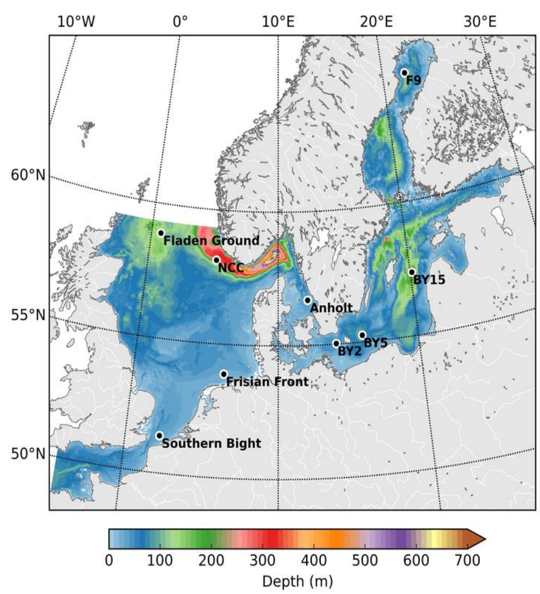
Elisa F. Guallart
Instituto Español de Oceanografía, Spain

The spectrophotometric technique to measure ion carbonate in seawater was first published in 2008 and has been continuously evolving in terms of reagents and formulation. Although being fast, relatively easy and inexpensive, it is not widely used in the OA community either for time series monitoring or experiments. We have collected 10 cruises (2009-2020) with overdetermined CO_2 system measurements (ion carbonate, pH and alkalinity) to check the evolution in terms of consistency of the ion carbonate method.

5. “Gaining insights into ocean CO_2 system inconsistencies from discrete fCO_2 measurements”

Maribel García-Ibáñez
University of East Anglia, UK

The CO_2 internally consistency (agreement between calculated and measured variables) in the ocean is still far from being attained within reasonable uncertainty limits. This is particularly important in the era of autonomous observations for surface and water column pH and surface fCO_2. Using overdetermined CO_2 data from WOCE + CLIVAR and GOSHIP cruises we study the consistency between measured and calculated fCO_2 either from pH & DIC or from TA & DIC.



CREDIT: Hordoir et al., 2018 (https://doi.org/10.5194/gmd-2018-2)

Session 8 — Northeast Atlantic Hub, Part 2

13:00 Greenwich Mean Time (UTC) = 15:00 Central European Summer Time (UTC +2)

Pre-register here: http://bit.ly/NEAHub_Part2

1. "Cuttlefish buoyancy in response to food availability and ocean acidification"

Eve Otjacques
University of Lisbon, Portugal

Carbon dioxide concentration in the atmosphere is expected to continue rising by 2100, leading to a decrease in ocean pH in a process known as ocean acidification (OA). OA can have a direct impact on calcifying organisms, including on the cuttlebone of the common cuttlefish *Sepia officinalis*. Moreover, nutritional status has also been shown to affect the cuttlebone structure and potentially affect buoyancy. Here, we aimed to understand the combined effects of OA (980 µatm CO_2) and food availability (fed vs. non-fed) on the buoyancy of cuttlefish newborns and respective cuttlebone weight/area ratio (as a proxy for calcification). Our results indicate that while OA elicited negative effects on hatching success, it did not negatively affect the cuttlebone weight/area ratio of the hatchlings—OA led to an increase in cuttlebone weight/area ratio of fed newborns (but not in unfed individuals). The proportion of "floating" (linked to buoyancy control loss) newborns was greatest under starvation, regardless of the CO_2 treatment, and was associated with a drop in cuttlebone weight/area ratio. Besides showing that cuttlefish buoyancy is unequivocally affected by starvation, here, we also highlight the importance of nutritional condition to assess calcifying organisms' responses to ocean acidification.

2. "Mechanism of local adaptation to natural variability in pH in marine calcifiers"

Sam Dupont
University of Gothernburg, Sweden

The role of local adaptation in biological response to ocean acidification is increasingly acknowledge in the field of ocean acidification. Monitoring and understand the ecological niche at the right spatio-temporal scale (weather) is key to understand the sensitivity of any organism and ecosystems. However, the role of the variability in relevant carbonate chemistry parameters as a driver is often overlooked. Biological activity on the coastal zone is often creating high level of variability. For example, the balance between respiration and photosynthesis over the night/day cycle is leading to pH/pCO_2 variability in seagrass beds. We hypothesized that (i) marine calcifiers exposed to such variability would develop some adaptive mechanisms to anticipate and respond to this variability; (ii) these mechanisms would reach their limit under ocean acidification. We used artificial seagrass beds in flow through mesocosms fed with seawater with 4 different pCO_2. The resulting variability in carbonate chemistry was monitored and biological response of a marine calcifier (sea urchin larvae) to this day/night variability was documented over 2 weeks. Growth and net calcification were measured twice a day (low pCO_2 during the day, high pCO_2 during the night). Results suggest that sea urchin larvae possess mechanisms to anticipate the variability in carbonate chemistry, downregulating their calcification during the night. These results will be discussed in the light of local adaptation, phenotypic plasticity and future response to ocean acidification.

3. "Ocean Acidification Impacts on Framework-Forming Cold-Water Corals"

Kelsey Archer Barnhill
University of Edinburgh, UK

The European Project on Ocean Acidification (OA), United Kingdom OA programme, and research programmes such as ATLAS and iAtlantic have contributed to better understanding OA impacts on cold-water corals (CWC). While living CWC can adapt to acidic waters, continuing to calcify even in aragonite undersaturated waters, dead, exposed CWC skeletons are threatened with dissolution. As the majority of CWC reef framework consists of dead corals, the vulnerability of exposed skeletal material to 'coralporosis' could lead to lower 3-dimensional complexity in reefs, decreasing habitats and associated biodiversity. Understanding the timescales at which porosity occurs across different IPCC projections, identifying the critical tipping point at which the porous skeleton can no longer support living colonies, and quantifying the interaction of OA with other drivers such as increased temperature and decreased oxygen could help predict and monitor future CWC health.

4. "Simplification, not 'tropicalization', of temperate marine ecosystems under ocean warming and acidification"

Jason Hall-Spencer
University of Plymouth, UK; University of Tsukuba, Japan

Increasing anthropogenic carbon dioxide is causing the warming and acidification of the oceans at an unprecedented rate, altering the biogeographical distributions of marine organisms. Coral reefs are now dying because heat waves have started to exceed the upper thermal limits of scleractinian corals in the tropics although some species are colonizing areas where greater feeding pressure by warm water fish is contributing to the loss of kelp forests. Taken together, these shifts are causing what has been termed the 'tropicalization' of temperate marine ecosystems. A lack of research into the effects of warming and acidification on natural ecosystems has left major gaps in our ability to understand and plan for their combined effects. Here, we conducted field surveys and in situ transplantation at natural analogues for present and future conditions under i) ocean warming and ii) both ocean warming and acidification. We show that increased herbivory by warm water fish exacerbates the loss of kelp and that ocean acidification negates benefits from the warming of the cooler temperate waters for the growth and physiology of tropical corals. Our data show that as the combined effects of ocean acidification and warming ratchet up then marine coastal ecosystems will continue to experience mortalities of foundation species with a loss of kelp forests not being replaced by scleractinian corals. We caution that the term 'tropicalization' is inappropriate in this context, as it brings to mind benefits, whereas in fact the simplification of marine habitats due to increased CO_2 levels cascade through the ecosystem and impair the provision of goods and services.

5. "Exposure of commercial shellfish to changing pH levels: how do we scale-up experimental evidence to regional impacts?"

Silvana Birchenough
Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK

Ocean acidification has become one of the most studied topics in the last 15 years. However, most of the research published to date suggests that acidification will act differently across species, with both direct and indirect effects for ecosystems. The field of research is advancing rapidly, with benefits observed, particularly, in the better design of experiments. They have moved from the individual organism or single species response to one stressor, to the more detailed and applied mesocosm type of approaches covering multiple stressors. There are challenges, with experiments testing different pH values, different end points, and some examples still showing some contradictory results for certain test species. As such, our efforts to bring this information together, to support analysis and assessments is somehow disjointed. Wider tools to 'scale-up' some of these observed changes (e.g. via modelling approaches on ecosystems) are still needed. Of particular importance are the observed effects on commercial species and predicting the likely effects on economic resources and the ecosystem effects; fundamental questions that will need to be tackled to support fisheries and aquaculture. Integration on a multidisciplinary level is needed to progress the science and offer suggestions on adaptive strategies for safeguarding marine ecosystems. This paper attempts to assess the current state of play from experiments to modelling approaches. Our approach is to combine different sources of information on OA effects to document a wide UK view on how commercial species would be likely affected in the future under modelled pH conditions. We conclude that the current experimental evidence does not offer insights into impacts at projected UK pH levels, and that future experiments must be designed to consider the pH levels experienced by organisms already, the modelled future pH values, and the expected overlap in pH range from the present day and the future. This information is key to inform decision making and planning for an effective ocean acidification monitoring and management programme for future changes to commercial shellfish stocks.


CREDIT: NOAA Fisheries

Session 9 — Friends of GOA-ON

15:00 Greenwich Mean Time (UTC) = 11:00 Eastern Daylight Time (UTC -4)

Pre-register here: http://bit.ly/Friends_Of_GOA-ON

1. The Global Ocean Observing System (GOOS) in support of ocean acidification observations

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[1]**GOOS, the Global Ocean Observing System**;
[2]GEOMAR Helmholtz Centre for Ocean Research - Kiel, Germany; [3]International Ocean Carbon Coordination Project, Institute of Oceanology, Polish Academy of Sciences, Poland

The Global Ocean Observing System (GOOS) is working to break down barriers between open-ocean and coastal observing, between scientific disciplines, and between operational and research institutions. The GOOS 2030 Strategy and Framework for Ocean Observing (FOO) provides guidelines for the setting of requirements, assessing technology readiness, and assessing the usefulness of data and products, and outlines a vision for the global ocean observing system, where closer cooperation and coordination with partners forms a center-piece. We will frame GOOS in view of these two documents and look at the partnership between the two organizations for mutual benefit and increased synergy.

2. The Marine Biodiversity Observation Network (MBON): Understanding Life in the Sea through Essential Ocean Variables (EOVs) and Esential Biodiversity Variables (EBVs)

Frank Muller-Karger
MBON, the Marine Biodiversity Observation Network;
University of South Florida College of Marine Science, USA

The Marine Biodiversity Observation Network, established within the Group on Earth Observations (GEO) Biodiversity Observation Network (GEO BON), is a community of practice for the collection, curation, analysis, and communication of marine biodiversity data. MBON seeks to strengthen understanding of marine biodiversity. It helps link and coordinate monitoring programs focused of changes in biodiversity over time through scientific observations, thereby facilitating ecosystem conservation, sustainability, and good management practices. This requires coordination and collaboration between countries, organizations, and individuals involved in the Group on Earth Observations (GEO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and many other organizations. A marine component to the Asia-Pacific BON has begun, called AP MBON, and MBON has initiated the development of an America's Pole to Pole BON (P2P). Additionally, MBON is engaged with the Global Coral Reef Monitoring Network (GCRMN) which aims to become a coral reef MBON. The expansion of marineGEO internationally is underway, and options for the development of a European MBON, perhaps including Africa, are being explored. MBON has a Secretariat sponsored by the AIR Center in the Azores, one at NOAA IOOS for the US MBON elements, and one at JAMSTEC in Japan for the AP MBON.

3. The Ocean Foundation's International Ocean Acidification Initiative: Removing barriers to monitor, understand, and respond to ocean acidification
Alexis Valauri-Orton
TOF, The Ocean Foundation

As the only community foundation for the ocean, The Ocean Foundation has a mission to support and strengthen those individuals and organizations dedicated to reversing the trend of ocean destruction. The Ocean Foundation's International Ocean Acidification Initiative (IOAI) seeks to improve equity and access to the knowledge and technology required to monitor, understand, and respond to ocean acidification. Through each of its activities, the IOAI works to lower the cost and complexity of addressing ocean acidification in order to ensure that all coastal communities have the ability to respond to this threat. The IOAI accomplishes this by providing direct financial support to researchers, sponsoring travel to scientific conferences, leading in person and remote technical trainings on policy and science; brokering regional agreements in high level political forums; providing one on one science and policy coaching; and directly distributing technology to fill gaps.

This talk will focus on the IOAI's support for GOA-ON and its members, including the development and deployment of the ""GOA-ON in a Box"" monitoring kit, the Pier-2-Peer scholarship fund, and efforts to connect scientists to their local governments to strengthen science-based adaptation and mitigation programs.

4. From Knowledge to Action- Engaging Governments and Stakeholders with OA Action Plans and Case Studies.
Jessie Turner
The International Alliance to Combat OA

Stakeholders and decision-makers at local, regional, and international scales are collaborating to respond to the accelerating global threat of ocean acidification (OA) and other climate-ocean impacts. Members of the OA Alliance are helping to promote and drive implementation of actions, including nature-based solutions, that address the causes of ocean acidification and increase biodiversity, adaptive capacity and resiliency of coastal communities.

Facilitated through the OA Alliance, national, subnational, regional and Tribal governments are proactively responding to the impacts of ocean acidification as they create OA Action Plans to effectively promote solutions and advancing knowledge into action.

The Global Ocean Observing System GOOS

MBON Marine Biodiversity Observation Network

The Ocean Foundation

OA Alliance INTERNATIONAL ALLIANCE TO COMBAT OCEAN ACIDIFICATION

Session 10 — Capstone Presentation

20:00 Greenwich Mean Time (UTC) = 13:00 Pacific Daylight Time (UTC -7)

Pre-register here: http://bit.ly/GOA-ON_Capstone

This session will feature a panel discussion and Q&A with the co-chairs of GOA-ON and a co-chair of the International Scientific Committee for the upcoming 5th International Symposium on the Ocean in a High-CO2 World.

1. Jan Newton
GOA-ON; University of Washington, USA

2. Bronte Tilbrook
GOA-ON; Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

3. Jean-Pierre Gattuso
International Scientific Committee, 5th International Symposium on the Ocean in a High-CO2 World; Laboratoire d'Océanographie de Villefranche, Sorbonne Université, France;
Institute for Sustainable Development and International Relations (IDDRI-SciencesPo), France

GOA-ON Global Ocean Acidification Observing Network

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

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*=presenting author

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 webpage: https://bit.ly/OAWeek2020.

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