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6.1 Intergovernmental Oceanographic Commission (IOC)

Enevoldsen, Burkill

IOC report for SCOR, 2015

Ocean acidification

Ocean acidification (OA) is an emerging global concern and is a risk to marine biodiversity, ecosystems and human society. In terms of new research and networking, the IOC is co-leading the Global Ocean Acidification Observing Network (GOA-ON) which is aimed to coordinate and improve ocean observation to detect the impacts of ocean acidification. The GOA-ON roadmap was published in September 2014 and the most recent development was the establishment of a biological working group, co-chaired and coordinated by IOC-UNESCO, in order to improve measurements detecting the impact of increasing CO₂ levels on marine life. Furthermore, together with the support of the Ocean Acidification International Coordination Center of the IAEA, a session focusing on OA during the Third International Symposium on the Effects of Climate Change on the World's Oceans in March 2015 in Santos, Brazil. COP20, was organized. To enhance the awareness among policymakers, IOC contributed to a side event in Lima during the COP20 and currently prepares OA workshops and side events towards the COP21. Regarding communication with the general public and permanent delegations at UNESCO, IOC celebrated the World Oceans Day, which included one session on ocean acidification. The TV corner, which was produced for the Second International Ocean Research Conference in November 2014, received a lot of positive feedback and was used again during other occasions.

Blue Carbon

The Blue Carbon Initiative, established in 2011 by the IOC, the International Union for the Conservation of Nature (IUCN) and Conservation International (CI) works to develop management approaches, financial incentives and policy mechanisms for ensuring the conservation, restoration and sustainable use of coastal blue carbon ecosystems. The IOC is highly involved in the Blue Carbon Scientific Working Group, which provides the scientific foundation for the Blue Carbon Initiative by synthesizing current and emerging science on blue carbon and by providing a robust scientific basis for coastal carbon conservation, management and assessment. Priority research of the Scientific Working Group functions in close partnership with the Initiative's Policy Working Group. Internationally applicable standards for quantifying and monitoring carbon storage, sequestration, and emissions in coastal ecosystems on regional and local scales were identified and the manual "Coastal Blue Carbon: methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows" was published and launched at the last meeting of the Scientific working group of the Blue Carbon Initiative in Rio Grande, Brazil, in October 2014. The distribution via internet in its pdf format is ongoing.

De-oxygenation

De-oxygenation is a global problem in coastal and open regions of the ocean, and has led to expanding areas of oxygen minimum zones and coastal hypoxia. In the coastal ocean, the

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number of reported dead zones has increased exponentially since the 1960s, with more than 479 systems now. The recent expansion of hypoxia in coastal ecosystems has been primarily attributed to global warming and enhanced nutrient input from land and atmosphere. The global extent and threat to human health and marine ecosystem services of ocean deoxygenation are just beginning to be appreciated; the social and economic consequences have yet to be determined, but are likely to be significant. Therefore the IOC supports a group of scientists trying to create awareness among policymakers and the general public, e.g. via publishing a scientific fact sheet via the 'Ocean and Climate' platform on deoxygenation, as well as via assisting in the establishment of a global network of experts within this field.

Time Series

In a growing effort to distinguish between natural and human-induced Earth system variability, the IOC is paying attention to sustained ocean time-series measurements. Shipboard biogeochemical time-series programmes provide the oceanographic community with the multi-year, high-quality data needed for characterizing ocean biogeochemistry and ecosystem variability and have taken a renewed importance as they represent one of the most valuable tools that scientists have to characterize and quantify ocean fluxes and their associated links to ecosystem functioning in a changing ocean. Under the auspices of the IOC, the International Group for Marine Ecological Time Series (IGMETS), compiled data from more than 400 time-series sites worldwide. It is envisaged that the analysis of these data sets, to be published in November 2015, will serve to disentangle natural and human-induced change in marine ecosystems. The initiative shows that the assessment of present data is critical to improve the information delivered to decision makers so that they understand marine ecosystem responses to a changing climate and plan accordingly.

IOC Joint action with ICES and IMO on Ballast and other Ship Vectors

The ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) critically reviews and reports on the status of shipping vector research, with an emphasis on new developments in ballast water treatment technology, risk assessment, ballast water sampling devices, and selection of ballast water exchange zones. The WG also discusses and evaluates the sampling strategies to ensure that international guidelines are based on accurate scientific information, thereby helping to achieve consensus on difficult technical issues.

In 2015, the WG continued to critically review and report on the status of shipping vector research, with an emphasis on studies of shipping transport vectors, shipping vector management activities and risk assessment. WGBOSV discussed and evaluated sampling and analysis strategies for type approval and compliance testing of ballast water treatment technologies under consideration at IMO or by other regulators (e.g. U.S. Environmental Protection Agency). WGBOSV further discussed and evaluated available information on the effects of treated or exchanged ballast water on the aquatic environment and provided input on strategies which could be used to increase confidence surrounding environmental safety of treated ballast water being discharged. Other terms of reference were to provide input to WGITMO in connection with OSPAR 1/2015 request, to review a draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition, and to investigate and report on new developments in non-native species issues in the Arctic, as a result of climate change and resource development. Finally, WGBOSV investigated and reported (incl. via AquaNIS) on new molecular tools for

identification, early detection and monitoring of non-native species, in collaboration with the ICES Working Group on Integrated Morphological and Molecular Taxonomy (WGIMT). The Full report is available at <http://www.ices.dk/community/groups/Pages/WGBOSV.aspx>.

Nutrient's coastal Impacts research

Nutrient over-enrichment of coastal ecosystems is a major environmental problem globally, contributing to problems such as harmful algal blooms, dead zone formation, and fishery decline. Yet, quantitative relationships between nutrient loading and ecosystem effects are not well defined. The IOC Nutrients and Coastal Impacts Research Programme (N-CIRP) is focussing on integrated coastal research and coastal eutrophication, and linking nutrient sources to coastal ecosystem effects and management in particular. A key component in the implementation strategy is a four-year Joint UNEP-IOC Global Environment Facility (GEF) Project 'Global foundations for reducing nutrient enrichment and oxygen depletion from land-based pollution' which was launched in March 2012. The IOC is leading the Project research component, which delivers global and local models for impact of nutrient loading. As part of the implementation strategy for N-CIRP, IOC also actively participates in a UNEP-led 'Global Partnership on Nutrient Management' (GPNM) with intergovernmental organizations, non-governmental organizations and governments. GPNM has an online information portal to enable GPNM partners to monitor progress on implementing activities related to the sustainable use of nutrients. The platform provides a knowledge hub, networking opportunities and promotes global discussions on sustainable nutrient management.

Microplastics

The Group of Experts on the Scientific Aspects of Marine environmental Protection (GESAMP) WG 40 'Sources, fate and effects of micro-plastics in the marine environment: a global assessment' has completed its work under the leadership of the IOC-UNESCO. It has started a second phase with a joint co-sponsorship shared by the IOC, UNEP and FAO. The new TORs were agreed by the three organizations, plus GESAMP, and the kick-off meeting was held in Rome on 21-23 April 2015. The most immediate milestone for this group is to present a report on the impact of microplastics on fish by May 2016. The IOC is also acting as an advisory body on potential plastics projects funded by the European Union Joint Programming Initiative on Oceans (EU JPI Oceans).

Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socio-Economic Aspects – World Ocean Assessment

IOC continued to follow closely the preparation of the World Ocean Assessment (WOA) report under the UN Regular Process, providing technical comments to the chapters related to its expertise. IOC also contributed financial resources to assist the UN Division for Ocean Affairs and the Law of the Sea (DOALOS) with the editorial process of the report. In December 2014, the Secretariat of the Regular Process (Division of Ocean Affairs and Law of the Sea) informed the Commission that the draft of the first global integrated marine assessment of the Regular Process was completed and ready to be reviewed by Member States and relevant intergovernmental organizations. Through [IOC Circular letter 2564](#), IOC Member States were invited to take part in the review process that concluded on 15 March 2015. In parallel, the IOC secretariat also provided a technical review for the chapters particularly relevant to the IOC field

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of expertise.

The WOA report is now being finalized by the Group of Experts and will be ready in September 2015 for consideration by the UN Ad Hoc Working Group of the Whole. In the context of the WOA consideration by UN Member States, an evaluation of the 1st cycle of the Regular Process implementation may be conducted, reviewing the effectiveness of the arrangements and drawing lessons for improving the next cycle of the Regular Process.

In 2009, the Group of Experts leading the Assessment of Assessments (preliminary phase of the Regular Process) recommended that the Regular Process be serviced by an inter-agency secretariat co-located in one single intergovernmental organization. However, when the General Assembly decided to set up the Regular Process and its arrangements, it was decided to establish the Secretariat within the Division on Ocean Affairs and the Law of the Sea (DOALOS) in New York. The impact of this decision has resulted in a limited engagement of relevant intergovernmental bodies and programmes such as FAO, UNEP, IMO and IOC, or of scientific advisory groups such as GESAMP, in the operations of the Regular Process. The adequate provision of supporting resources is critical to facilitate the work of the Group of Experts as well as the inclusion of the state-of-the-art scientific knowledge. The next cycle of the Regular Process may consider the use of indicators and reference points to compare status and trends over time. This would require a heavy investment in the development of an indicator-based methodology. This is an area where IOC, building on its experience with the Transboundary Water Assessment Programme (TWAP), is well placed to contribute to.

TWAP

IOC is leading the implementation of the marine components of the Transboundary Water Assessment Programme (TWAP) funded by GEF. The project will provide a number of core ecological, socio-economic and governance indicators for the marine environment (64 Large Marine Ecosystems and Open Ocean areas) using globally available datasets. From the IOC perspective, TWAP is the first integrated and global marine assessment that the Commission is leading, and the results produced have the potential to inform a number of ocean governance mechanisms; these include the GEF, other UN agencies with an ocean mandate, other global assessment processes such as WOA and Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES), regional seas organizations, and LME commissions, as well as Member States. In order to conduct this assessment, IOC established a consortium of institutional partners and experts for the current Open Ocean and LMEs assessments (these include for e.g. NOAA, IGBP, GESAMP, UNEP-WCMC, University of British Columbia, National Center for Ecological Analysis and Synthesis (NCEAS), amongst others). This consortium is crucial for the conduct of the assessments, as the members provide the necessary expertise, tools and data that underpin the assessments. The final TWAP deliverables will be released in September 2015, there will be two technical assessment reports (IOC Technical Series, 119, vol. 1: LME and Vol.2: Open Ocean; IOC/2015/TS/119) and a joint web portal displaying the indicators globally and providing access to the underpinning data. (see <http://www.geftwap.org>)

OBIS

OBIS continues to grow, with about 3 million species observations per year. It currently holds 45 million records, integrated from over 1,800 datasets.

The financial situation of the OBIS secretariat is now looking much better, with the project coordinator's position being covered by UNESCO's regular programme budget. This position is combined (50/50) with GOOS, to support the newly established Biology and Ecosystems Panel of GOOS.

The mission of GOOS Biology is: "By OceanObs'19, identify at least one (set of) GOOS variable providing a change indicator, globally coordinated with a clear pathway to global coverage, including open access data, and reporting to support international reporting needs (including SDGs, CBD reporting needs, a future World Ocean Assessment, etc.) – i.e. a mature GOOS programme. A further 3 (sets of) GOOS variables have been identified as pilot eEOVs with a clear pathway to progress them to mature variables." More information can be found on <http://www.ioc-goos.org/biology>.

OBIS and GOOS Biology are heavily involved in the developments of GEO MBON (a marine Biodiversity Observation Network as part of the Group on Earth Observation), in collaboration with GEO Blue Planet.

OBIS has received funding from the Flanders Government (Flanders UNESCO Science Trust Fund) to develop information products and services to support major ocean assessments, such as the World Ocean Assessment of the UN regular process and those of the new IPBES (Intergovernmental Platform on Biodiversity and Ecosystem Services). Within this project, OBIS is currently developing customized information portals on particular geographic or thematic issues.

OBIS continues to be an important information source for the identification of Ecologically or Biologically Significant Areas (EBSAs) of the Convention on Biological Diversity (CBD). A new pilot project has been approved by the IODE Committee (March 2015) to expand OBIS with additional data beyond species occurrence records (e.g. biological measurements, environmental measurements, water, sediment, etc.). The purpose is to ensure that mixed datasets (holding all measurements taken during a sampling event) are kept together; multiplying the value of these data for a multitude of science applications and ensuring that published results/analysis are reproducible.

IOC Capacity Development Strategy

During 2014-15 the Intersessional Working Group for the Development of the IOC Capacity Development discussed the proposal for the new IOC Capacity Development Strategy, to be implemented in the period 2015-2021.

The vision of IOC's Capacity Development Strategy is derived from the IOC Vision and High-Level Objectives for 2014-2021 (Resolution XXVII-2, 27th Session of the IOC Assembly) and also from risks and opportunities related to ocean and coasts.

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The vision statement of IOC's Capacity Development Strategy is: *“Through international cooperation, IOC assists its Member States to collectively achieve the IOC'S high-level objectives (HLOs), with particular attention to ensuring that all Member States have the capacity to meet them.”* Furthermore, the mission statement of IOC's Capacity Development Strategy states that *“The IOC will undertake relevant actions to assist Member States with developing and sustaining the necessary capacity to undertake activities necessary to achieve the IOC vision at the national level as well as at the international cooperation level.”*

The IOC CD Strategy defines 6 main outputs, each output including a number of activities to be developed towards pursuing IOC's CD vision. The outputs are: 1) Human resources developed; 2) Access to physical infrastructure established or improved; 3) Global, regional and subregional mechanisms strengthened; 4) Development of ocean research policies in support of sustainable development objectives promoted; 5) Visibility and awareness increased; and 6) Sustained (long-term) resource mobilization reinforced.

One key element towards the implementation of this CD Strategy is the development of sustained partnerships, where SCOR can play an important role. Such partnership(s) can involve, inter alia, joint fellowships and grant/travel awards as well as sharing/exchange of experts contributing lectures/contents to training courses and programmes, etc.

The new IOC Capacity Development Strategy, to be implemented in the period 2015-2021, was approved by the Member States in June 2015 during the IOC 28th Assembly.

OceanTeacher and OceanTeacher Global Academy

In 2014-15 OceanTeacher – IODE's Capacity Development (CD) tool – started the implementation of a new phase in Capacity Development. The new OceanTeacher Global Academy (OTGA), funded by the Government of Flanders (Belgium), aims at creating a network of Regional Training Centres (RTCs), thus moving from a centralized model to a distributed model for its CD activities.

The OTGA Project (2014-18) will:

- promote the establishment and assist with the start-up of Regional Training Centres that will plan, organize and implement training courses that are of relevance and serve the needs of the target region;
- promote the use of local experts as lecturers/training assistants by the RTCs;
- promote the collaboration between the RTCs by enabling (through advanced information technology) lecturers from multiple regions to contribute lectures; and
- further develop the use of the OceanTeacher Learning Platform.

During 2014, all candidate RTCs were visited and assessed for their adequacy to become part of the OTGA network of RTCs. The candidate RTCs spread across the globe, including Colombia, USA, Senegal, South Africa, Mozambique, Kenya, India, Malaysia, China and the already existing one in Belgium. In late 2014, a proposal from Samoa was also received.

In January 2015, the OTGA Steering Group (SG) met for the first time. During this meeting the

partners had the opportunity to meet and discuss some of the challenges of the project, including that the number of RTCs is twice as many as expected (the project expected 5 RTCs, while 10 applications were received). The OTGA SG agreed on the following main activities for 2015:

- Each RTC to organise at least one training course on an IODE-related topic;
- Definition of an ‘OTGA Global and Regional Communication and Outreach Strategy’ (implementation to start early 2016);
- Launch the regional training needs surveys.

The OTGA SG will meet again during the first quarter of 2016.

During the 2014-2015 the OceanTeacher Learning Platform has been improved and expanded to include courses from other IOC Programmes, and it now includes specific sections for the Harmful Algal Bloom (HAB), Coastal and Marine Management and Planning (MPR/ICAM), Tsunami and JCOMM, besides IODE. Altogether, over 20 new courses were added in 2014-15. In December 2014, during its 69th General Assembly, the UN Member States expressed their appreciation for IOC contribution towards CD through OT.

The OTGA SG calls for members from the SCOR community to contribute to OceanTeacher as lecturers.

IIOC-2

The IIOE-2 continues to be co-championed by SCOR, IOC and IOGOOS. This report does not repeat SCOR’s input on IIOE-2, but mentions a few salient IOC specific points as a supplement. IOC Assembly 28, June 2015, considered the Report on IIOE-2 submitted to it by the IOC IIOE-2 Interim Planning Committee (Group of Experts): *IOC/INF-1324, 26 May 2015: Strategic Framework for Implementation of the Second International Indian Ocean Expedition (Report of the IOC Second International Indian Ocean Expedition (IIOE-2) Interim Planning Committee.* That report is available via IOC websites (including www.iocperth.org). The Assembly consideration on IIOE-2 led to the adoption of a Resolution establishing, for IOC, the IIOE-2 as a new IOC project with a dedicated allocated budget and to run in conjunction with SCOR and the Indian Ocean Global Ocean Observing System Regional Alliance. IOC also endorsed the SCOR IIOE-2 Science Plan Development Committee’s Science Plan (Version 1, May 2015) as the adopted underpinning science framework for IIOE-2. In terms of secretariat support for IIOE-2, Australia (via the IOC Perth Programme Office) and India (via a resourced IIOE-2 International Project Office) combined to provide formative contributions and support for collaborative International Project Office Framework (IPO) model.

The IOC also agreed to extend the tenure of the IPC in order to facilitate it preparing an IIOE-2 Implementation Plan complementary to the Science Plan. The elements of the Implementation Plan, in terms of its structure and themes, will align with the recommendations of the IPC’s Report to Assembly 28, referring to a Steering Committee and an integrated set of Working Groups. The Implementation Plan is being prepared to be ready for the 4 Dec 29015 launch of IIOE-2 in Goa, India at the end of the II50 conference and it will be submitted to the Executive Council of the IOC at its 49th meeting in June 2016.

6.2 Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)

Urban

GESAMP WG 38 ATMOSPHERIC INPUT OF CHEMICALS TO THE OCEANS

2015 Report to SCOR from the Co-Chairs of Working Group 38

History of WG 38

Recognition continues to grow concerning the impact of the atmospheric input of both natural and anthropogenic substances on ocean chemistry, biology, and biogeochemistry as well as climate. In the 1980s, GESAMP formed a working group sponsored by WMO, UNESCO/IOC, and UNEP that developed a comprehensive review of the input of atmospheric trace species to the global ocean (GESAMP, 1989). That benchmark effort led to a scientific publication in *Global Biogeochemical Cycles* in 1991 that for more than 15 years was the state-of-the-art reference in this area, leading to over 1,300 citations in the literature. That paper is now 25 years old, and a new overall look at this issue was needed.

For this reason, Working Group 38 was formed during 2008 and it held its first meeting at the University of Arizona, Tucson, Arizona (USA), in December, 2008. Subsequent meetings were held at IMO in London in 2010, and Malta in 2011. Sponsors of those WG 38 efforts have included WMO, IMO, SCOR, SIDA, the European Commission Joint Research Centre, the University of Arizona, and the International Environment Institute at the University of Malta.

Following the initial terms of reference, as a result of the first working group meetings, five scientific papers have been published in the scientific literature. These include the following:

- 1) Okin, G., A. R. Baker, I. Tegen, N. M. Mahowald, F. J. Dentener, R. A. Duce, J. N. Galloway, K. Hunter, M. Kanakidou, N. Kubilay, J. M. Prospero, M. Sarin, V. Surapipith, M. Uematsu, T. Zhu, “Impacts of atmospheric nutrient deposition on marine productivity: roles of nitrogen, phosphorus, and iron”, *Global Biogeochemical Cycles*, **25**, GB2022, doi:10.1029/2010GB003858, (2011).
- 2) Hunter, K.A., P. S. Liss, V. Surapipith, F. Dentener, R. A. Duce, M. Kanakidou, N. Kubilay, N. Mahowald, G. Okin, M. Sarin, I. Tegen, M. Uematsu, and T. Zhu, “Impacts of anthropogenic SO_x, NO_x and NH₃ on acidification of coastal waters and shipping lanes”, *Geophysical Research Letters*, **38**, L13602, doi:10.1029/2011GL047720 (2011).
- 3) Kanakidou, M., R. Duce, J. Prospero, A. Baker, C. Benitez-Nelson F. J. Dentener, K.A. Hunter, N. Kubilay, P. S. Liss, N. Mahowald, G. Okin, M. Sarin, K. Tsigaridis, M. Uematsu, L.M. Zamora, and T. Zhu, “Atmospheric fluxes of organic N and P to the ocean”, *Global Biogeochemical Cycles*, **26**, GB3026, doi:10.1029/2011GB004277, (2012).

- 4) Schulz, M., J. M. Prospero, A. R. Baker, F. Dentener, L. Ickes, P. S. Liss, N. M. Mahowald, S. Nickovic, C. Pérez García-Pando, S. Rodríguez, M. Sarin, I. Tegen, R.A. Duce, “The atmospheric transport and deposition of mineral dust to the ocean - Implications for research needs”, Environmental Science and Technology, 46, 10,390-10,404 (2012).
- 5) Hagens, M., K.A. Hunter, P.S. Liss, and J.L. Middelburg, “Biogeochemical context impacts seawater pH changes resulting from atmospheric sulfur and nitrogen deposition”, Geophysical Research Letters, 41, doi:10.1002/2013GL058796 (2014).

More Recent Activities of WG 38

Additional terms of reference for continued work of GESAMP WG 38 were approved in 2012 to address issues related to the impact of the atmospheric deposition of anthropogenic nitrogen to the ocean. The additional tasks added were as follows:

- A. Update the geographical estimates of anthropogenic nitrogen deposition to the global ocean made in the 2008 paper in *Science* (Duce, R.A., et al., “Impacts of atmospheric anthropogenic nitrogen on the open ocean”, *Science*, 320, 893-897, 2008), which were based on data from 2005 and earlier. This would utilize newer and more geographically distributed data on anthropogenic atmospheric nitrogen concentrations and deposition over the global ocean, as well as improved models of these processes and impacts;
- B. Considering issues related to Task 1 above, re-evaluate the impact of atmospheric nitrogen deposition on marine biogeochemistry, including re-estimating the amount of CO₂ that could be drawn down from the atmosphere into the ocean as a result of the increased productivity in the ocean derived from the additional anthropogenic nutrient nitrogen deposited. This would allow an update on the impact of the atmospheric nitrogen deposition on atmospheric radiative properties outlined in the 2008 *Science* paper;
- C. Provide a more reliable estimate of the impact of atmospheric anthropogenic nitrogen deposition on the production of additional nitrous oxide in the ocean and its subsequent emission to the atmosphere. This was one of the greatest uncertainties in the 2008 *Science* paper;
- D. Evaluate the extent to which anthropogenic nitrogen delivered to the coastal zone via rivers, atmospheric deposition, etc. is transported to the open ocean, in which regions this may happen, and what its impact is there. In the 2008 *Science* paper, it was assumed that all nitrogen delivered to the coastal zone was sequestered there and did not reach the open ocean, but this may not be true in all locations; and
- E. Make a more detailed estimate of the input and impact of anthropogenic nitrogen in the area of the Northern Indian Ocean (Arabian Sea, Bay of Bengal) and the South China Sea - the areas that are expected to show the greatest increase of anthropogenic nitrogen deposition over the next few decades.

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To address these new terms of reference, a highly successful workshop on The Atmospheric Deposition of Nitrogen and Its Impact on Marine Biogeochemistry was held at the University of East Anglia in Norwich, United Kingdom, from 11 to 14 February 2013. Twenty-three scientists participated in the workshop. The first day of the workshop was devoted to discussions of the five tasks identified above as the foci of the workshop. Two participants were asked to summarize the issues in each of these task areas and to lead the discussions that followed. On the basis of the task area discussions above, the workshop participants broke up into sub-groups on the second through fourth days of the workshop. These sub-groups began the development of a number of different scientific papers, covering the task areas above. This newest work by WG 38 has been supported by WMO, IMO, SCOR, the University of East Anglia, and the US National Science Foundation.

Since the Norwich workshop one paper has been published:

- 6) Kim, T.-W., K. Lee, R.A. Duce and P.S. Liss, “Impact of atmospheric nitrogen deposition on phytoplankton productivity in the South China Sea”, Geophys. Res. Lett., DOI: 10.1002/2014GL059665 (2014).

One additional paper has been submitted for publication:

- 7) Somes, C.J., A. Landolphi, W. Koeve, and A. Oschlies, “Ocean biogeochemical feedbacks limit the impact of atmospheric nitrogen deposition on marine productivity”, Submitted to the Proceedings of the National Academy of Sciences (2015).

Five additional papers are in preparation, and all should be submitted before the end of 2015. This includes a major summary paper on our current understanding of the impact of atmospheric nitrogen deposition on marine biogeochemical cycling, led by Tim Jickells, and a paper comparing observation and model-based estimates of atmospheric nitrogen deposition to the ocean, led by Alex Baker.

Potential Future Activities of WG 38

Following its successful 2014 session at the European Geosciences Union (EGU) meeting, WG 38 again organized a session on atmospheric input of chemicals to the ocean for the 2015 EGU meeting, held in Vienna, Austria in April 2015. Papers at this session were presented by a combination of WG 38 members and other scientists. The co-chairs; several members of WG 38; and officials from the Atmospheric Environment Research Division, World Meteorological Organization, met at the 2015 EGU meeting and began to discuss possible additional tasks for WG 38. Since then, WG members have developed three possible proposals for future WG 38 activities and these (see summaries below) were presented at GESAMP 42 in Paris in September, 2015. GESAMP approved these new initiatives, assuming that appropriate funding could be obtained.

Workshop on the Impact of Ocean Acidification on Fluxes of Atmospheric non-CO₂ Climate-Active Species

Earlier investigations on the impact of ocean acidification (OA) have primarily focused on

changes in oceanic uptake of anthropogenic CO₂, the resulting shifts in carbonate chemical equilibria and the consequences for marine calcifying organisms. Very little attention has been paid to the direct impacts of OA on the ocean sources of a range of other gaseous and aerosol species (including N₂O, CH₄, DMS, and marine VOCs and halocarbons important in tropospheric chemistry and particle formation) that are influential in regulating radiative forcing, atmospheric oxidising capacity (via OH and O₃ cycling) and atmospheric chemistry. The oceanic processes governing emissions of these species are frequently sensitive to the changes in pH and ocean pCO₂ accompanying ocean acidification. The direct and indirect influences of these oceanic processes (e.g., microbial metabolic rates, levels of surface primary production, ecosystem composition, etc.) on ocean fluxes of non-CO₂ trace gases and aerosols, and the subsequent feedbacks to climate remain highly uncertain. The aim of this proposed project would be to review and synthesize the current science on the direct impact of OA on marine emissions of these other key species; identify the primary needs for new research to improve understanding of these processes and quantify the impact of OA on marine fluxes; publish the results in the open peer-reviewed scientific literature, and provide input to and interact with national and international research programs on OA (e.g., UKOA, NOAA-OAP) and with relevant WMO programmes.

Workshop on Changing Atmospheric Nutrient Solubility

Atmospheric deposition of nutrients to the ocean is known to play a significant role in regulating marine productivity and biogeochemistry, in turn potentially impacting the drawdown of CO₂ from surface seawater as well as the production of other climate-active gases (e.g., N₂O and DMS). The specific impact is dependent on the nutrient in question, the location of the deposition (more significant impact where a particular nutrient is in short supply), and the bioavailability of the deposited nutrient. Bioavailability is largely governed by the chemical speciation of a nutrient and, in general, insoluble species are not bioavailable. For Fe and P, solubility increases during transport through the atmosphere. The causes of this increase are complex, but interactions of aerosol particles with acids appear to play a significant role. Past and future changes in anthropogenic emissions of acidic (SO₂ and NO_x) and alkaline (NH₃) gases have had and likely will have an impact on the acidity of the atmosphere downwind of major urban/industrial sources, with potential consequences to the supply of soluble nutrients to the ocean. Concurrent with this change in acidity there are likely to be other changes which may also impact marine productivity rates and microbial species population composition. The aim of this proposed workshop would be to review and synthesize the current scientific information on solubility of key biogeochemical elements, their pH sensitivity and the biogeochemical controls on the pH sensitivity; identify the key future research needs that are necessary to reduce uncertainties in predictive capability in this area; publish the results in the open peer-reviewed scientific literature; and interact with and provide information to leading relevant international groups (e.g., SOLAS, IGAC, IMBER, SCOR) and WMO programmes such as GAW.

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Possible Funding for These Two Workshops

Both the WMO and IMO have indicated that they will provide some financial support for these 2 workshops if they go ahead. Preliminary discussions have been held with personnel at the U.S. National Science Foundation and with Dr. Ed Urban at SCOR about the possibility of NSF once again providing partial funding for these workshops, through SCOR, as it did for the earlier Nitrogen Workshop. The discussions of this possibility will continue, and if it is decided that this is feasible, a proposal from SCOR to the National Science Foundation might be submitted sometime during the first half of 2016. At its annual meeting in Kiel, Germany in September, 2015 SOLAS indicated its support and willingness to collaborate on these two workshops if they go forward.

Possible Workshop for the Integrated Nitrogen Management System (INMS)

A third future activity proposed by WG 38 is the assessment of the impact of nitrogen on the marine environment as a contribution to the Integrated Nitrogen Management System (INMS). INMS is a global targeted research project with the aim to provide clear scientific evidence to inform future international nitrogen policy development. INMS's core funding comes from the Global Environment Facility (GEF) (the environment funding mechanism of the United Nations System) with the United Nations Environment Program (UNEP) as the Implementing Agency and the UK Natural Environment Research Council (Centre for Ecology and Hydrology) as the Executing Agency acting on behalf of the International Nitrogen Initiative (INI). WG 38 is in an excellent position to bring together observational scientists and atmospheric modeling groups to address these issues. Funding for this effort would come from the INMS. The expertise needed would be very different for the three activities, and thus it is likely that there would be very little overlap in participants at the planned workshops. WG 38 members would act as an overall executive committee and engage other experts for each of the projects.

New Co-Chair of WG 38

Prof. Peter Liss, who has served as an outstanding co-chair of WG 38 since its inception, has asked to step down from that position and Prof. Timothy Jickells, an internationally renowned atmospheric and marine chemist from the University of East Anglia, has agreed to become Co-chair of WG 38. Dr. Jickells has been involved with WG 38 activities for many years and is the lead author on the primary nitrogen paper that is coming out of the current WG 38 work on nitrogen deposition to the ocean and its impacts. At its Paris meeting, GESAMP approved this change in WG 38 leadership.

6.3 North Pacific Marine Science Organization (PICES)

Batchelder, Sun Song