solas event report

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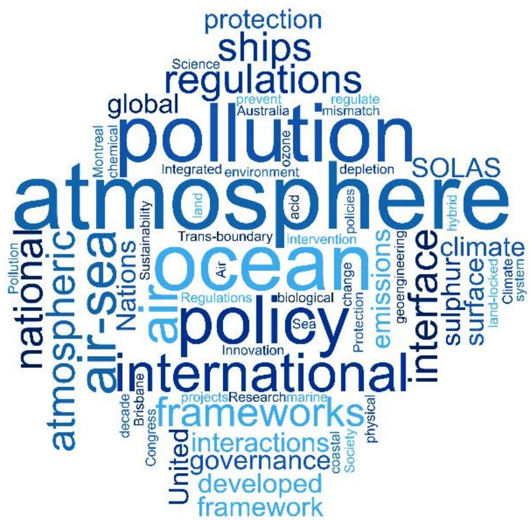
Sustainability Research & Innovation Congress 2021 (SRI2021)

Session on: "The apparent mismatch between science and policy at the air-sea interface"

12 – 15 June 2021 Hybrid in Brisbane, Australia



A forum session on "The apparent mismatch between science and policy at the air-sea interface" for the Sustainability Research & Innovation Congress was held, which builds on topics included in the launch of the SOLAS Science and Society Integrated Topic (Marandino *et al.*, 2020). The congress took place in Brisbane, Australia from 12 – 15 June, 2021 as a hybrid event.

The very existence of international projects such as SOLAS shows that, from the perspective of natural sciences, the boundary between the ocean and the atmosphere cannot be clearly drawn. There are many physical, chemical and biological interactions between the surface of the ocean and the lower part of the atmosphere. The policy perspective, however, tends to make a clear distinction between the ocean and the air directly above it, without much consideration of the interaction between them. Regulatory frameworks for the governance of the ocean on the one hand and the atmosphere on the other reflect this compartmentalisation. The international regulatory framework for the ocean bases itself

In this report

Figure 1: Participants of SOLAS session at Sustainability Research & Innovation Congress 2021 (SRI2021). From upper left to lower right: Erik van Doorn, Christa Marandino, Anna Rutgersson, Cliff Law, Robert A. Duce, Andrew Lenton, Nathalie Hilmi, Lisa Miller, Fadzilah Majid Cooke, Clément Brousse, Bill Miller, David Kieber.

mainly on the 1982 United Nations Convention on the Law of the Sea (LOSC). The atmosphere lacks a global, all-encompassing regulatory framework like the LOSC since the international rules for the atmosphere developed later than the customary international law of the sea. Regional efforts on long-range transboundary air pollution, with a focus on acid rain, occurred first in the 1970s with the 1979 Convention on Long Range Trans-boundary Air Pollution. On a global level, past efforts have concentrated on air pollution, with a focus on the depletion of the ozone layer in the 1980s through the 1985 Vienna Convention for the Protection of the Ozone Layer and 1987 Montreal Protocol. In the next decade, regulation addressed climate change with the 1992 United Nations Framework Convention on Climate Change as a starting point.

We aimed to consider whether the interaction between the lower atmosphere and the upper layer of the ocean is sufficiently addressed in policy and regulations. Regulations need not target the air-sea interface directly but should regulate the source of pollution (e.g., atmospheric emissions at the national and regional levels) or designated areas in need of a higher protection (e.g., sulphur control areas for ships). The rationale behind this is that the regulation of activities on land or on ships (i.e. the cause of atmospheric pollution) is mostly a sovereign duty of states, whether land-locked, coastal or flag states, which is exercised in line with their national policies. There is nevertheless a general obligation under the LOSC for states to prevent, reduce and control pollution of the marine environment from or through the atmosphere.

In sum, although the interaction between the surface of the ocean and the lower part of the atmosphere is critical to the functioning of the Earth system, public policy tends to make a clear distinction between the ocean and the air directly above it, without much consideration of the interaction between them. The session addressed the following topics:

- The compartmentalisation of regulatory frameworks for the governance of the ocean on the one hand and the atmosphere on the other. How the interaction between the lower atmosphere and the upper layer of the ocean is currently addressed in policy and regulations.
- The need for regulations explictly targetting the air-sea interface directly versus regulation

of the pollution sources (e.g., atmospheric emissions at the national and regional level) or designated areas in need of a higher protection (e.g., sulphur control areas for ships). How regulatory frameworks being developed for climate intervention (i.e., geoengineering) can be formulated to address air-sea interactions.

The SOLAS session took place virtually and included four introductory talks (see specific sections below) and a panel discussion. The speakers were: Robert A. Duce, Emeritus Professor, Texas A&M University, USA; Anna Rutgersson, Professor, Uppsala University, Sweden; Nathalie Hilmi, Researcher, Centre Scientifique de Monaco; and Andrew Lenton, Senior Research Scientist, CSIRO. The panellists were a mixture of the conveners (listed below) and the speakers (Fig. 1). In order to kick off the panel discussion, we polled the audience on the following list of questions:

- Which targets of the Sustainable Development Goals 13 on climate action and 14 on life in the ocean contradict each other, and how can we resolve this?
- From the perspective of a natural scientist, is it still feasible to separate the policy framework for the atmosphere completely from that for the ocean?
- Do the legal frameworks explicitly have to account for ocean-atmosphere interactions or is the status quo workable enough?
- How do regulations for international maritime traffic address the interaction between the ocean and the atmosphere?
- Is there a need to incorporate rules on climate intervention in order to achieve the 1,5 degree goal as laid down in the 2015 Paris Agreement?
- What should these rules allow for or maybe even encourage?

Conveners

- Erik van Doorn, Kiel University, http://www.wsi.uni-kiel.de/en/the-team/research-associate/erik-van-doorn-1?set_language=en
- David J. Kieber, State University of New York, USA http://www.esf.edu/faculty/kieber
- Christa Marandino, GEOMAR - Helmholtz Centre for Ocean Research Kiel, Germany http://www.geomar.de/en/mitarbeiter/fb2/ch/translate-to-english-marandino-christa
- Lisa Miller, Fisheries and Oceans Canada – Institute of Ocean Sciences, Canada http://lmiller173.wixsite.com/lisamillerocean
- William L. Miller, University of Georgia, USA http://www.marsci.uga.edu/directory/people/william-miller

Reference

Marandino, C., van Doorn, E., McDonald, N., *et al*. (2020), From Monodisciplinary via Multidisciplinary to an Interdisciplinary Approach Investigating Air-Sea Interactions – a SOLAS Initiative, *Coast. Manage.*, 48(4), 238-256. http://doi.org/10.1080/08920753.2020.1773208

Chemicals and the air-sea interface – who cares?

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Two examples are given about the air/sea exchange of human-derived substances, how they were (or are) related to environmental concerns and societal issues, and what was (or may be) done about them policy-wise – a historical example from ~fifty years ago (lead), and an issue only now becoming of possible concern (microplastics). A planned regional workshop is also described bringing together scientists, managers and policymakers to address the apparent mismatch between science and policy at the air-sea interface.

In the 1950s/1960s, concern arose about lead emitted from vehicles because of tetraethyllead used in gasoline and its associated health related issues. The manufacturer of the tetraethyllead clearly stated there was no need for concern. But Clair Patterson of the California Institute of Technology, United States of America, strongly disagreed. Patterson was the first person to accurately date the age of the earth as ~4.5 billion years, using lead isotopes. During this research, he found that lead contaminated everything in his laboratory. He determined that the source for this lead was the burning of fuels containing tetraethyllead. Patterson then began looking at lead in the earth's most remote regions in the 1960s/1970s, including Greenland and Antarctic ice cores and the atmosphere and ocean (Figure 2). He found much higher lead concentrations in oceanic surface waters than deeper waters, as expected if the oceanic lead was from the atmosphere. The highest surface lead concentrations were in the North Atlantic Ocean, downwind from heavily industrialised North America. Patterson's dedicated work on lead in ice cores, the atmosphere and the ocean, and his constant and loud demand that it be removed from fuel, including many testimonies before Congress, finally overcame the strong manufacturer's protests, resulting in laws phasing lead from US gasoline in the later 1970s. And when lead was basically shut-off, how did the ocean respond? Studies by Wu and Boyle (1997) near Bermuda showed that the surface water lead concentration dropped

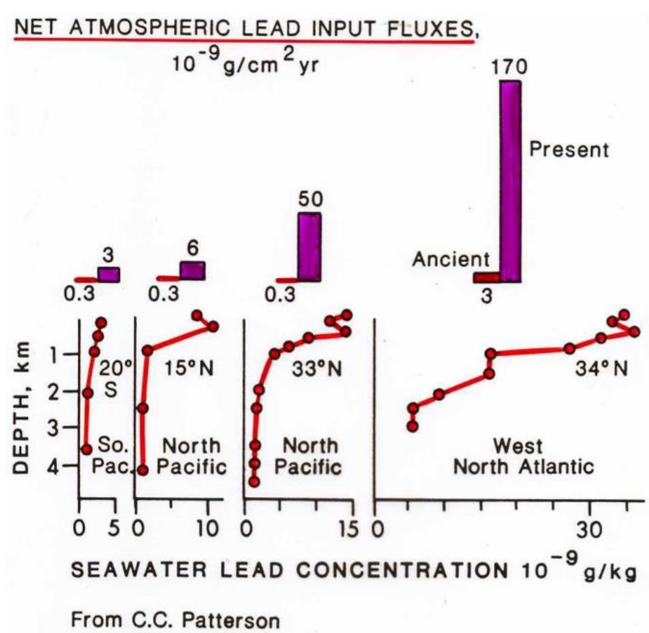

Figure 2: Atmospheric lead input fluxes to the ocean and seawater lead concentrations in the 1970s.

from ~35 ng/kg in the very late 1970s to ~seven ng/kg in the late 1990s, clearly showing the impacts of Patterson's demands that lead be removed from gasoline.

The second example concerns a substance currently gathering increased interest relative to air/sea chemical exchange – microplastics. Liss (2010) made a rough estimate that up to ten MT/yr of microplastics might be deposited in the ocean from the atmosphere – similar to the estimate for riverine transport to the ocean of five to fifteen MT/yr (Jambeck, *et al.*, 2015). However, actual data on atmospheric microplastics over the ocean are few and most do not give mass information, only number data, as determined by microscopic measurements. The working group on air/sea chemical exchange of the United Nations Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) recently held a workshop entitled "The Atmospheric Transport of Microplastics to and from the Ocean". This workshop called for an expanded and coordinated global-scale research effort on microplastics to understand and quantify their atmospheric sources, long-range transport, concentration distribution, and exchange processes and fluxes between the atmosphere and ocean. There has been very little legislation to date dealing with microplastics, so as research efforts expand in this area it will be important to include managers and policymakers in the planning efforts.

GESAMP's working group has planned a regional workshop in South Africa in October 2022 to address ocean management and policy implications of the air/sea exchange of the nutrients nitrogen and iron from biomass burning and industrial emissions in the southern Africa region. It will particularly look at potential impacts on ocean productivity in the Madagascar Channel and Southwest Indian Ocean. The workshop will include international scientists as well as environmental managers and policymakers from that region.

One of the activities will involve scientists presenting specific case studies and explaining what they see as the environmental issues that arise from the case study. Managers will consider if this information would lead them to recommend specific actions and policymakers would then consider if they would be willing to act on this advice. This would test the most appropriate approaches for scientists to engage with managers and policymakers to evaluate scientific evidence of environmental trends and their associated uncertainties. Hopefully, this approach will help to address, at least on a regional scale, one apparent mismatch between science and policy at the air-sea interface.

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The apparent mismatch between science and policy in the air-sea interface: A shipping approach

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Shipping is the most widely used medium for transport of goods internationally and will continue to increase. Although shipping is a carbon-efficient transport medium, there is an increasing focus on its broader environmental consequences. For a sustainable and equitable use of the oceans, as well as minimising impacts of global change, a further development to sustainable shipping, or green shipping, is needed. Ship building and operational standards are introduced and area-based instruments, such as emission control areas (ECAs), are established. However, lack of regulations, vague monitoring, unclear environmental impacts and economic uncertainty might cause problems for industry and society. In the project ShipTRASE (www.shiptrase.eu), the environmental, economic and legal aspects of both near-term and long-term solutions to shipping emission reduction and control mechanisms will be analysed. The potential environmental impacts on the lower atmosphere and upper ocean include those from pollutant emission from ship smokestacks and liquid discharge, as well as increased methane-induced greenhouse warming. For full understanding a transdisciplinary approach is required, also stakeholder involvements (industry, local government, large scale regulation). In ShipTRASE various platforms are used: in-situ measurements, scrubber laboratory measurements, numerical modeling, cost-benefit analysis, and survey methodologies. ShipTRASE will deliver an economic and environmental consequence analysis of implementation of control areas. In addition, we assess the impact of policy settings and regulation.

Often in science, we aim to answer scientific questions being of use in society and for legislation (science influencing policies and legislation). In the case of ship emissions, control areas are established as a result of political decisions. These were motivated by the emissions of aerosols and air quality problems. However, one implication was the open-loop-scrubbers and scrubber wash water discharge. The scrubbers have potentially ecological and biogeochemical effects on the marine environment but the extent of this is still to a large extent unknown (Endres *et al.*, 2018; Turner *et al.*, 2017a; Turner *et al.*, 2017b). Thus, new science is being initiated and needed as a result of the new legislation (policies

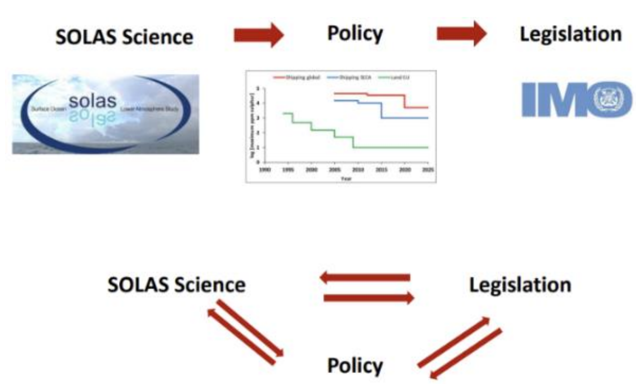

Figure 3: Illustration of the science and policy interaction needed for the development of an environmental-friendly shipping industry Please explain what IMO stands for

and legislation influences science). For a more effective scientific and societal development, it is beneficial with a mutual communication between science and policies (Figure 3), and to involve stakeholders when developing the scientific questions in the cases when this is relevant.

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Aknowledgements

Session organisers Erik van Doorn and Christa Marandino, and also the ShipTRASE team.

Are there solutions to reduce the impacts of CO_2 emissions on the ocean and human well-being?

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The United Nations' Intergovernmental Panel on Climate Change's (IPCC) Special Report on the Ocean and Cryosphere (SROCC), approved in Monaco in September 2019, considered the impacts of climate change on the ocean, its threats and the ecosystem services that it provides and the link to Sustainable Development Goals (SDGs). We will see first that the ocean has an important role in human well-being. Secondly, we will mention the main physical changes in the ocean. Third, we will consider the socio-economic impacts. Finally, the concept of nature-based solutions, blue carbon and carbon conservation show that for economists the link between science and policy is evident, especially at the air/sea interface.

The oceans provide a variety of good and ecosystem services to human beings. It is a primary source of protein for 2.6 billion people and represents fifteen percent of Gross Domestic Product (GDP) in two dozen countries. They are not only a major source of food, they also produce oxygen, absorb carbon dioxide, play a main role in climate regulation and provide energy as well as recreational services. It is the source for medical compounds.

The oceans provide an important and rich source of economic value. They are part of commercial shipping and tourism, with more than half of tourist guest nights spent in coastal areas. Oceans are also an important source of energy, as a source of not only fossil fuels, marine minerals, commodities and services but also renewable energy and renewable biofuels. Forty percent of households globally depend on the oceans for their livelihoods. About half of the world's population lives within the coastal zone and ocean-based businesses contribute more than $500 billion to the world's economy.

The oceans and their resources have made development possible in all countries throughout the world, and they continue to contribute greatly to poverty alleviation and food security in the coastal and inland communities of the world's developing nations. On the one hand, the oceans are recognised as very important providers of resources with high monetary values. On the other hand, the human activities that have made exploitation of these valuable resources possible also pose many threats to marine environmental sustainability through disruption of ecological functions, which are especially vulnerable to pollution, overfishing and degradation of habitats.

According to the SROCC, global warming has already reached 1°C above the preindustrial level, due to past and current greenhouse gas emissions. There is overwhelming evidence that this is resulting in profound consequences for ecosystems and people. The ocean is warmer, more acidic and less productive. Melting glaciers and ice sheets are causing sea level rise and coastal extreme events are becoming more severe. Greenhouse gases will cause physical changes. Climate change will have impacts on ecosystems, ecosystem services and the blue economy.

Many ecosystems will be damaged by global warming even if temperatures increase is limited to 2°C. Some of them will benefit from ambitious mitigation to 1.5°C. Corals are already at high risk and coral reef restoration options may be ineffective if global warming exceeds 1.5°C. But marine habitat restoration, and ecosystem management tools such as assisted species relocation and coral gardening, can be locally effective in enhancing ecosystem-based adaptation.

The marine animal biomass is projected to decrease sharply if no mitigation policy is implemented. This will impact the food security of the coastal communities dependent on fisheries for their protein intake because the changes in the ocean will impact the net primary production, the total animal biomass and the maximum catch potential, especially in the worst scenario. Moreover, because the global demand for seafood continues to increase.

Human systems and natural systems are closely related. Ocean warming and acidification, loss of oxygen and changes in nutrient supplies are already affecting the distribution and abundance of marine life in coastal areas, in the open ocean and at the sea floor. The changes in the ocean and the cryosphere combined with other human impacts will have severe consequences on the biodiversity, on the economy and on human well-being. Climate change impacts on marine ecosystem services reduce the society's ability to achieve most other sustainable development goals.

The ocean is important and it is urgent to take the right decisions. The restoration of vegetated coastal ecosystems, also known as blue carbon, could increase carbon uptake and storage and help to achieve the Paris agreement goals thanks to the carbon removal as stated in article 6 of the Paris Agreement.

There are some gaps in the SROCC about the concept of blue carbon. In fact, wide-range of ocean-based response options are available.

They are supported by protection, restoration, precautionary ecosystem-based management of renewable resource use, reduction of pollution and other stressors. They permit moderate to high benefits to local climate-risk reduction, but also high co-benefits and low trade-offs.

There are specific policy responses in the context of adaptation and nature-based solutions. A few examples include, reducing other pressures such as pollution and habitat modification will help species adjust to changes in their environment. Or policy frameworks for integrated water management, fisheries management and networks of protected areas offer opportunities for people and species to adapt. Lastly, nature-based adaptation such as ecosystem restoration can be locally most effective when community supported, science based and connected with local knowledge and indigenous knowledge. Such approaches bring multiple benefits for biodiversity, humans and, in some circumstances, climate mitigation.

According to the SROCC, enabling climate resilience and sustainable development depends critically on urgent and ambitious emissions reductions coupled with coordinated sustained and increasingly ambitious adaptation actions.

(Nathalie Hilmi is one of the drafting authors for SROCC).

Kim Magalona is a graduate student for George Mason University's Department of Environmental Science and Policy, USA, where she is studying the microbiome of Virginia's Chesapeak Bay striped bass population. Aside from her knowledge in microbial studies, Kim is interested in further contributing to marine conservation research, Specifically relating to fisheries, coral reefs restoration and marine wildlife protection. Aside from her fellowship with the Global Sustainability Scholars (GSS), she also volunteers as a researcher for the Florida Fish and Wildlife Research Institute's (FWRI) Sea Turtle Migration program and as a rescue volunteer for the Clearwater Marine Aquarium's (CMA) stranding team.

Student Event Highlight

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During the Sustainability Research and Innovation (SRI) Congress 2021, I had the pleasure of attending SOLAS session on "The apparent mismatch between science and policy at the air-sea interface." Erik van Doorn was the main host for the session and introduced the speakers, Dr. Bob Duce, Dr. Anna Rutgersson, Dr. Nathalie Hilmi, and Dr. Andrew Lenton. During these presentations, the presenters touched on the different scenarios where discrepancies between science and policy in the air-sea interface were present. One example that caught my eye was from Dr. Duce's presentation. Dr. Duce speaks about the increasing issue of oceanic microplastics and their increased presence in one-hundred species of marine biota including finfish, shellfish, and crustaceans. The primary source of microplastics is generally found on land and there is growing evidence that the atmosphere plays a key role in this pathway of microplastics from land to sea. There was a microplastics workshop that was held by the United Nations Scientific Aspects of Marine Environmental Protection (GESAMP) in 2020 where scientists came together to address this situation. Due to the lack of data to date, there is little legislations in dealing with microplastics. As research continues to expand in this area, it is important to efforts at an early stage, including managers and policy makers in the research planning efforts at an early stage.

As presentations came to an end, there was an opportunity for the audience to ask questions in the SRI chat function. This provided an easier, indirect way for the audience to engage with the panel and helped diminish the intimidating social wall that others experience when attending a virtual conference or workshop. Our questions were relayed by Dr. Christa Marandino. In the beginning of the conference, the audience was also asked to vote for a question that they wanted to ask the panel, allowing a unique aspect for the viewers, and introducing different types of engagement. The flow of the conference was well done, with the individual spotlight done for each speaker and then multiple spotlights done for the entire panel. The technical aspects gave a wonderful visual for thering transdisciplinary research and its importance in creating environmental policy and its link to the SRI conference.

Attending the apparent mismatch of between science and policy at the air-sea interface session was an enlightening experience. As scientists continue to recognise the holes in environmental research and management, we can further establish collaboration between fields and the need to continue interdisciplinary research on earth system studies.

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