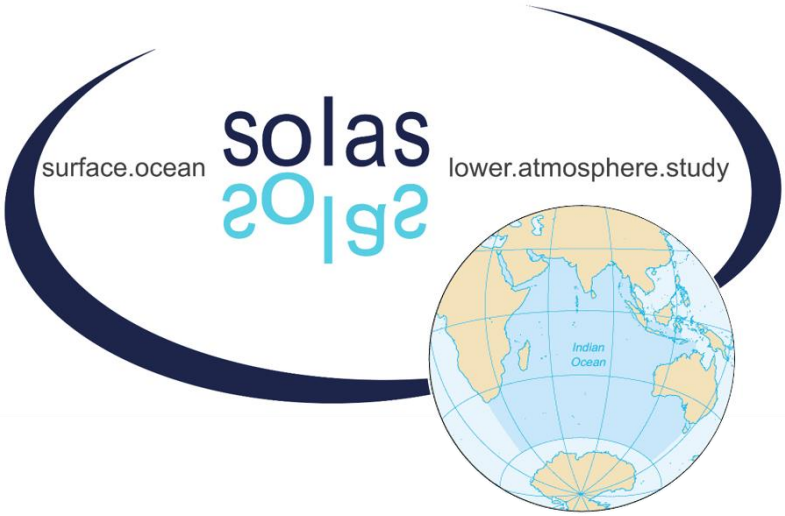
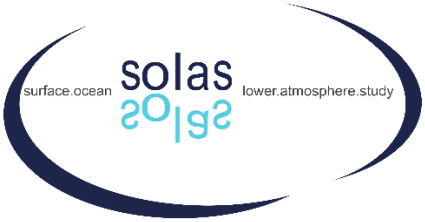


SOLAS Indian Ocean Meeting

30th September 2020, Online

Book of Abstracts



SOLAS Indian Ocean Meeting

AGENDA
All times in IST

8.30 - 8.45 **SOLAS Welcome and Introduction**
Lisa Miller (Institute of Ocean Sciences, Canada)

Morning Session
Chair: Hermann Bange (GEOMAR, Germany)

8.45 - 9.15 **Keynote 1**
The context of the Indian Ocean and air-sea exchange research: What do we know so far?

- Christa Marandino (GEOMAR, Germany)

9.15 - 9.45 **Session 1**
The air-sea interface and boundary-layer exchange of trace gases in the Indian Ocean

- Manish Naja (Aryabhatta Research Institute of Observational Science , India)
- Nidhi Tripathi (Physical Research Laboratory, India)

9.45 - 10.15 **Session 2**
Air-sea exchange and monsoons

- Swapna Panickal (Indian Institute of Tropical Meteorology, India)
- Roxy Mathew Koll (Indian Institute of Tropical Meteorology, India)

10.15 - 10.45 **Poster session**
Moderators: Parvadha Suntharalingam (University of East Anglia, United Kingdom) and N. Anilkumar (National Centre for Polar and Ocean Research, India)

11.00 - 14.00 **Break**

11.00 - 11.30 Break

11.30 - 13.30 SOLAS India meeting

13.30 - 14.00 Break

14.00 **Afternoon Session**
Chair: Susann Tegtmeier (University of Saskatchewan, Canada)

14.00 - 14.30 **Session 3**
Impacts of the atmosphere on the Indian Ocean (including pollution)

- Arvind Singh (Physical Research Laboratory, India)
- Michal Strzelec (Institute for Marine and Antarctic Studies, Australia)

14.30 - 15.00 Session 4

Impacts of ocean biogeochemistry and microbiology on the atmosphere over the Indian Ocean

- Liselotte Tinel (University of York, United Kingdom)
- Carolin Löscher (University of Southern Denmark, Denmark)

15.00 - 15.30 Keynote 2

Going forward from here: the IIOE-2 and its legacy

- Peter Burkill (University of Plymouth, United Kingdom)

15.30 - 16.00 Panel Discussion

Where are the gaps that need to be filled and how can we do that?
Moderator: Lisa Miller (Institute of Ocean Sciences, Canada)

- Katye Altieri (University of Cape Town, South Africa)
- Hermann Bange (GEOMAR, Germany)
- Vinaychandran (Indian Institute of Science, India)

16.00 Closing

*SOLAS India Meeting

AGENDA
All times in IST

11.30 - 11.45 Introduction to SOLAS

Lisa Miller (Institute of Ocean Sciences, Canada)

11.45 - 12.00 Keynote presentation: The SOLAS national community in Israel

Yoav Lehahn (University of Haifa, Israel)

12.00 - 12.15 Overview of SOLAS activities in the India Ocean

Sheryl Fernandes (Institute of Ocean Sciences, India)

12.15 - 12.30 Possible SOLAS contributions to future Indian Ocean region research programs

Hermann Bange (GEOMAR, Germany)

12.30 - 13.30 Structure and future of SOLAS India and increasing collaborations with ongoing programs in India

Anoop Mahajan (Indian Institute of Tropical Meteorology, India)

SPEAKERS' ABSTRACTS

The abstracts in this section are arranged in order of their appearance in the meeting agenda.

Morning session

Chair: Hermann Bange, GEOMAR, Germany

ATMOSPHERIC GAS-PHASE COMPOSITION OVER THE INDIAN OCEAN

Christa Marandino, GEOMAR, Germany

The Indian Ocean region is influenced by several unique mechanisms, such as the seasonally varying monsoon circulation. During the winter monsoon season, high pollution levels occur over the entire northern Indian Ocean, while during the summer monsoon, clean air dominates the atmospheric composition, leading to distinct chemical regimes. The changing atmospheric composition over the Indian Ocean can interact with oceanic biogeochemical cycles and impact marine ecosystems, resulting in potential climate feedbacks. I will review current progress in detecting and understanding atmospheric gas-phase composition over the Indian Ocean and its local and global impacts. Although we know that changing atmospheric composition and perturbations within the Indian Ocean affect each other, the impacts of atmospheric pollution on oceanic biogeochemistry and trace gas cycling is understudied. I highlight potential mechanisms, future research topics and observational requirements to be explored in order to fully understand interactions between the Indian Ocean and the overlying atmosphere.

TRACE GASES OVER THE ARABIAN SEA, THE BAY OF BENGAL AND THE INDIAN OCEAN

Manish Naja, Aryabhatta Research Institute of Observational Science, India

The understanding of chemical, physical, and dynamical processes over oceanic regions in tropical Asia is more complex due to its proximity to the land masses having diverse emissions sources at one place together with their increasing levels, higher water vapour and intense solar radiation. Despite this, oceanic regions in tropical Asia are still not well studied. The monsoon system, over this region, is one of the largest regional climate phenomena and has major influence on the redistribution of trace species, even at the greater distances and altitudes. This talk will brief upon the past studies of trace gases in the Arabian Sea, the Bay of Bengal and the Indian Ocean with a stock on present status. Differences in trace gas variabilities among these three oceanic regions will be discussed and gap areas will be pointed.

AIR-SEA EXCHANGE OF VOLATILE ORGANIC COMPOUNDS (VOCS) OVER THE ARABIAN SEA

Nidhi Tripathi, Physical Research Laboratory, India

Biogenic volatile organic compounds (BVOCs) play an important role in atmospheric chemistry as precursors of ozone and secondary organic aerosols. Ocean microbes and dissolved organic carbons are important sources of several non-methane hydrocarbons (NMHCs) in the remote marine atmosphere. The northern Indian Ocean, mainly the Arabian Sea, could be a strong source of reactive BVOCs due to relatively high ocean biological productivity. We have studied the concentrations of light alkenes measured in the marine air with the physical and biological parameters of surface seawater during the inter-monsoon period. The seawater and atmospheric parameters were used to explain the spatio-temporal variations of light NMHCs in the marine air over the highly productive northeast region of the Arabian Sea. The estimated emission fluxes of ethene and isoprene were higher than those reported for several other oceanic regions. Our observations highlight the need to evaluate the impact of biogeochemical processes controlling the oceanic emissions of NMHCs over the northern Indian Ocean. I will present the importance of biogeochemical processes and details of our study over the Arabian Sea.

CLIMATE CHANGE AND REGIONAL SEA LEVEL RISE; AN INDIAN OCEAN PERSPECTIVE

Swapna Panickal, Indian Institute of Tropical Meteorology, India

Sea level rise is one of the dominant impacts of anthropogenic global warming having major societal and geopolitical ramifications. Global mean sea level rise is caused by the warming of the ocean and by the melting of ice and glaciers. However, regional sea level rise deviate substantially from those of the global mean. Spatial patterns of sea level rise in the north Indian Ocean (NIO) show significant rise during last 3-4 decades. Analysis of long-term climate datasets and ocean model sensitivity experiments identifies a mechanism for the sea level rise in NIO relative to the global mean. Our results indicate that NIO sea level rise is accompanied by a weakening summer monsoon circulation. Given that Indian Ocean meridional heat transport is primarily regulated by the annual cycle of monsoon winds, weakening of summer monsoon circulation has resulted in increased retention of heat and increased thermosteric sea level rise in the NIO. These findings imply that rising north Indian Ocean sea level due to weakening of monsoon circulation demand adaptive strategies to enable a resilient South Asian population.

INDIAN OCEAN WARMING AND MONSOON EXTREMES

Roxy Mathew Koll, Indian Institute of Tropical Meteorology, India

The recent decades have seen a phenomenal increase in monsoon droughts and floods over India. While there is a reduction of up to 10% in the monsoon rains over central India, the extreme rainfall events have increased by three-fold. What are the factors intensifying the monsoon variability? If the monsoon circulation is weakening, why are we having extreme rains and floods? Can we predict these extremes well in advance? In this talk, we will try to see how the monsoon has changed during the past 6 decades, and provide important clues to some of these confounding questions.

Afternoon Session

Chair: Susann Tegtmeier, University of Saskatchewan, Canada

BIOAVAILABLE NITROGEN INPUTS IN THE NORTHERN INDIAN OCEAN

Arvind Singh, Physical Research Laboratory, India

Bioavailable nitrogen enters into the surface ocean through river inputs, atmospheric deposition and biological nitrogen fixation. In general, river and atmospheric inputs dominate over the coastal regions, whereas nitrogen fixation has been recently recognised to be the most important source of nitrogen in the open ocean. Somewhat contrary to this general understanding, our results indicate that the coastal Arabian Sea is a hotspot of N_2 fixation with some of the highest rates ever recorded in the world ocean. Contribution of atmospheric deposition to new nitrogen is 3% in the open northern Indian Ocean, while riverine inputs are mostly consumed within the estuarine ecosystems before entering into the Bay of Bengal. However, low atmospheric deposition contributes significantly to N_2O emissions in this region and has the potential to affect the biogeochemical cycling of the Arabian Sea and the Bay of Bengal.

FROM WESTERN AUSTRALIA TO THE INDIAN OCEAN – THE DELIVERY OF NATURAL AND ANTHROPOGENIC AEROSOL TRACE METALS DOWN-UNDER

Michal Strzelec, Institute for Marine and Antarctic Studies, Australia

The atmospheric delivery of aerosol trace metals link the terrestrial environment with marine ecosystems by providing nutrients, such as Fe, as well as toxins, which after deposition to the sea may be consumed by the marine biota. Aerosol samples, collected near the coast of the southern part of Western Australia, are expected to feed sensitive ecosystem of the Indian Ocean. Leaching protocols followed by elemental analysis of aerosol samples allow us to distinguish the soluble and refractory forms of trace metals.

Mineral dust appeared as the dominant type of aerosol and the main source of total Fe and was characterised by strong seasonal variation. The solubility of Fe was lower than aerosols collected on the eastern seaboard of Australia. Episodic bushfires caused an increase in emissions of anthropogenic metals and Fe solubility. Finally, source apportionment indicated a rather low and episodic contribution of local anthropogenic sources.

THE INFLUENCE OF THE SEA SURFACE MICROLAYER ON OCEANIC IODINE EMISSIONS

Liselotte Tinel, University of York, United Kingdom

The reaction of ozone with iodide at the ocean's surface is one of the main drivers for iodine emissions into the marine troposphere. Recent studies[1–3] in the Indian Ocean showed differences between observed and modelled iodine oxide in the marine boundary layer, pointing out an incomplete understanding of iodine emissions. Here, we present results of laboratory and modelling studies on iodine emissions (I_2) from the $O_3 + I^-$ reaction at the sea surface and the influence of organic compounds using artificial seawater, natural subsurface seawater and, for the first time, surface microlayer samples (SML). Compared to I_2 emissions over buffered KI solutions, emissions over artificial seawater were reduced, but the strongest reductions were observed over natural seawater samples. Our results highlight the importance of using environmentally representative concentrations in studies of the $O_3 + I^-$ reaction and demonstrate the influence the SML exerts on emissions of iodine, and potentially other volatile species.

HOW MICROBIAL COMMUNITY COMPOSITION DETERMINES THE FUTURE OF CARBON PUMPING AND GREENHOUSE GAS PRODUCTION IN THE TWO NORTHERN INDIAN OCEAN BASINS

Carolin Loescher, University of Southern Denmark, Denmark

Ocean primary production is the basis of the marine food web, sustaining life in the ocean via photosynthesis, and removing carbon dioxide from the atmosphere. The availability of organic matter largely determines oxygen consumption in waters below the euphotic zone. By generating low oxygen conditions, the production of greenhouse gases including nitrous oxide can be facilitated. The Arabian Sea and the Bay of Bengal are strongly antagonistic regarding their primary production, not necessarily regarding the total rates, but regarding the community composition of photosynthetic organisms. Further, carbon export efficiencies differ impacting the intensity of the two oxygen minimum zones, their biogeochemistry and greenhouse gas production. Recently, a decrease of global marine primary production has been reported based on ocean color data, which was mostly ascribed to decreases in primary production in the Bay of Bengal but not in the Arabian Sea.

In this presentation, I will discuss, based on available rates and community compositions, what this change in primary production means for the future of the carbon pump, the oxygen minimum zones, and the nitrous oxide production in the Arabian Sea and the Bay of Bengal, respectively.

INTERNATIONAL INDIAN OCEAN EXPEDITION 2 (IIOE-2): LOOKING FORWARD AND REFLECTING

Peter Burkill, SCOR Co-Chair IIOE-2, University of Plymouth, United Kingdom

IIOE-2 has been operating now for 5 years with co-sponsorship from IOGOOS, IOC as well as SCOR. Its focus has been broadly *to better understanding the Indian Ocean*. But this requires a context and one of these is *its role in the Earth System.* Addressing the former curiosity-lead science is now resulting in many publications, but the latter remains elusive. This must soon change, as one of the most significant findings in recent years has been that the Indian Ocean is warming faster than any other ocean. This has major consequences particularly for the people that live there. IIOE-2 is a candidate to interface to the new UN Decade of Ocean Science (2021-2030). This will broaden IIOE-2 and a future challenge will be how we balance fundamental research with more 'applied' research sought by the DECADE programme. My talk with cover this territory, addressing high-level issues, as a prelude to the discussions that will follow.