

Report for the year 2022 and future activities

SOLAS 'India'

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First things first...Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?

Partial/full support for bearing the article processing charges of SOLAS research since many ongoing independent research studies have no provision for bearing the aforementioned cost in peer reviewed SCI journals.

PART 1 - Activities from January 2022 to Jan/Feb 2023

1. Scientific highlight

Title: Substantial contribution of iodine to Arctic ozone destruction.

To establish the role of iodine in controlling tropospheric ozone over the Arctic, researchers from various countries conducted ship-based Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAIC) expedition onboard the German research icebreaker *Polarstern*. Observations from March to October 2020 showed that iodine enhanced springtime tropospheric ozone depletion.

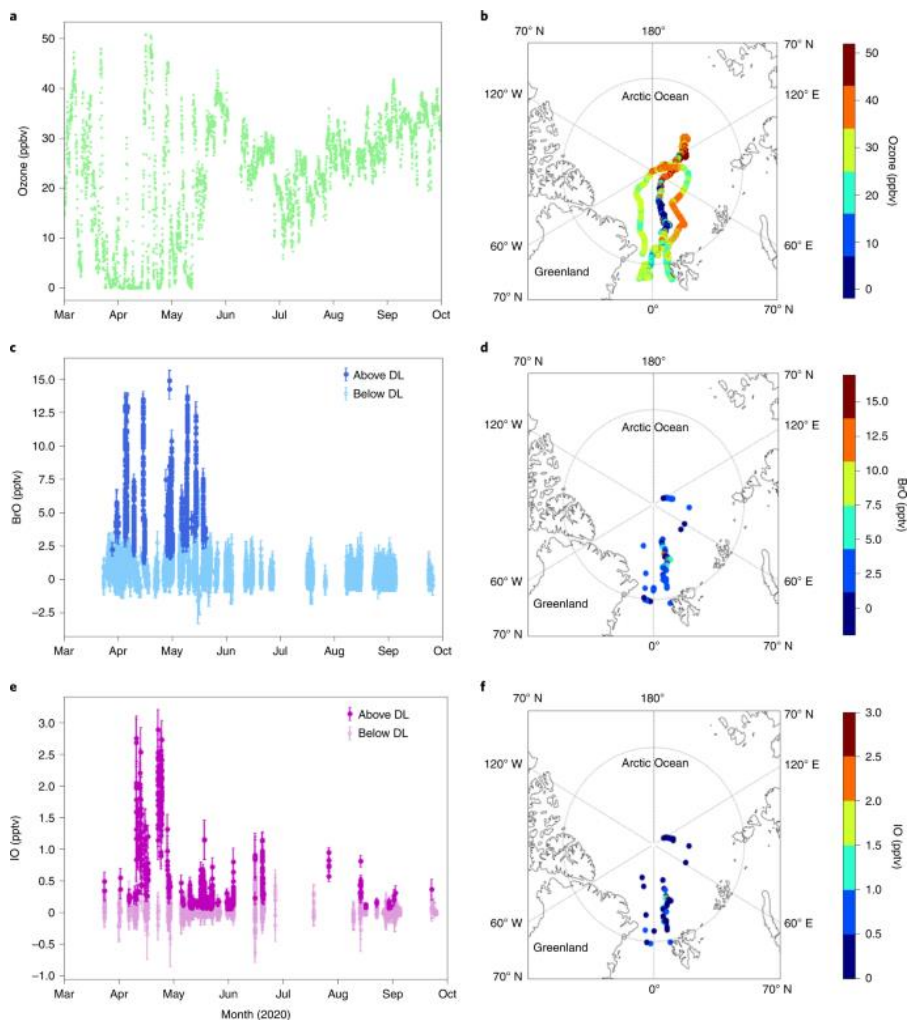


Fig. 1. Time series (**a, c, e**) and geographical distributions (**b, d, f**) of the ozone (**a, b**), BrO (**c, d**) and IO (**e, f**) mixing ratios as observed during the MOSAiC expedition. BrO was above the detection limit (DL) only during the spring, coinciding with drastic ozone depletion. IO mixing ratios were larger during the spring, but IO was also detected during the sunlit period throughout the expedition, showing its widespread nature. The error bars for the BrO and IO data include the sensitivity of the sum of squares with respect to variations of the fitted parameters around the minimum and the noise on the measurements, along with errors in the result due to the path length retrieval using the oxygen dimer.

Using a chemical model, it was revealed that chemical reactions between iodine and ozone are the second highest contributor to the loss of surface ozone, after the loss initiated by ozone photolysis, and ahead of bromine. This changed the decades-old paradigm on the drivers of Arctic photochemical ozone loss. The findings also suggested that the atmospheric increase in iodine loading due to enhanced anthropogenic ozone-induced ocean iodine emissions, as well as the thinning and shrinking of Arctic sea-ice expected in the near future, will probably lead to increases in iodine emissions. Iodine chemistry could play an increasingly important role in the future and must be considered for accurate quantification of the ozone budget in the Arctic.

Citation: Benavent, N., Mahajan, A.S., Li, Q., Cuevas, C.A., Schmale, J., Angot, H., Jokinen, T., Quéléver, L.L.J., Blechschmidt, A.-M., Zilker, B., Richter, A., Serna, J.A., Garcia-Nieto, D., Fernandez, R.P., Skov, H., Dumitrascu, A., Simões Pereira, P., Abrahamsson, K., Bucci, S., Duetsch, M. 2022. Substantial contribution of iodine to Arctic ozone destruction. *Nature Geoscience*, 15(10): 770–773.

2. Activities/main accomplishments in 2022 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).

- Dr. Roxy Mathew Koll, Scientist E, Indian Institute of Tropical Meteorology (IITM), Pune, was appointed member of the WCRP Climate and Ocean: Variability, Predictability and Change (CLIVAR) Core Project Scientific Steering Group (SSG) for the period 2023-2026.
- Dr. Ashwini Kumar, Senior Scientist, CSIR-National Institute of Oceanography (NIO) received funds from SERB, DST Govt. of India under CRG scheme by, Goa for his project entitled “*Quantification of mineral dust sources and associated trace metal composition over the Bay of Bengal*”.
- The Prydz Bay Air-Sea-Ice Experiment (PRAISE) field campaign 2022-23 was successfully completed, and the expedition members returned on 11th February 2023 from Bharati station, Antarctica. As part of the campaign, the team collected air samples, water samples, CTD, Vertical microstructure profiler, and sea ice cores for the understanding of Air-Ice-sea interaction in Eastern Coastal Antarctica.
- Scientists from National Centre for Polar and Ocean Research (NCPOR), Goa are part of a European Union (EU) funded project ‘*Climate Relevant Interactions and feedbacks- key role of sea ice and snow in the polar and global climate system (CRiceS)*’ which focuses on improving model predictions of the role of polar processes in the climate system that consists of the oceans, ice and snow cover, and the atmosphere.
- Collaboration between NCPOR has been developed with British Antarctic Survey (BAS), UK, for DEFIANT (Drivers and Effects of Fluctuations in sea Ice in the ANTArctic) project.
- Four scientific sections were conducted at SCAR 2022 to discuss the recent progress in the atmosphere as well as the ocean components of the Southern Ocean Research.
- International Indian Ocean Science Conference (IIOSC-2022) was held from 14th to 18th March 2022 at CSIR-National Institute of Oceanography, Goa. The conference provided a forum for interagency discussions of Indian Ocean research and a liaison between the scientific community and agencies
- CREODIAS conference was held on 16th November 2022 for utilization of Sentinel data.
- RISAT-1A satellite user meeting was held at New Delhi on 13th December 2022. Brainstorming session at the meeting provided inputs on the widespread application of Space Technology in various fields like Earth and Climate Studies, Agriculture, Water Resources, Land Use/Land Cover, Geosciences, Disaster Management Support, Forestry and Ecology.
- Manuscript submitted for publication in SOLAS special issue - *Elementa: Science of the Anthropocene*:
Kumar, A., Tegtmeier, S., Fernandes S.O., Biswas, H., Girach, I., Roxy, M.K., Kurian, S., Marandino, C.A., Sarma, V.V.S.S., Shenoy, D.M. Surface ocean-lower atmospheric processes in the Indian Ocean: Current understanding, knowledge gaps and future directions.

3. List of SOLAS-related publications published in 2022 (only PUBLISHED articles) and if any, web links to models, datasets, products, etc.

- Abdulla, C.P., Aboobacker, V.M., Shanas, P.R., Vijith, V., Sajeev, R., Vethamony, P. 2022. Climatology and variability of wind speeds along the southwest coast of India derived from Climate Forecast System Reanalysis winds. *International Journal of Climatology*, 42(16): 8738-8754.
- Aswini, M.A., Tiwari, S., Singh, U., Kurian, S., Patel, A., Gunthe, S.S., Kumar, A. 2022. Aeolian Dust and Sea Salt in Marine Aerosols over the Arabian Sea during the Southwest Monsoon: Sources and Spatial Variability. *ACS Earth and Space Chemistry*, 6(4): 1044-1058.
- Aswini, M.A., Tiwari, S., Singh, U., Kurian, S., Patel, A., Gunthe, S.S., Kumar, A. 2022. Aeolian dust and sea salt in marine aerosols over the Arabian Sea during the southwest monsoon: Sources and spatial variability. *ACS Earth and Space Chemistry*, 6(4): 1044-1058.
- Benavent, N., Mahajan, A.S., Li, Q., Cuevas, C.A., Schmale, J., Angot, H., Jokinen, T., Quéléver, L.L.J., Blechschmidt, A.-M., Zilker, B., Richter, A., Serna, J.A., Garcia-Nieto, D., Fernandez, R.P., Skov, H., Dumitrascu, A., Simões Pereira, P., Abrahamsson, K., Bucci, S., Duetsch, M. 2022. Substantial contribution of iodine to Arctic ozone destruction. *Nature Geoscience*, 15(10): 770–773.

- Bharathi, M.D., Venkataramana, V., Sarma, V.V.S.S. 2022. Phytoplankton community structure is governed by salinity gradients and nutrient composition in the tropical estuarine system. *Continental Shelf Research*, 234: 104643.
- Bhaumik, A., Fernandes, V., Biswas, H. 2022. Report of Epibiont Diatom *P. pacificum* on the Cyclopoid Copepod *D. affinis* from the Southwestern Shelf Waters of India (Eastern Arabian Sea). *Thalassas: An International Journal of Marine Sciences*, 38 (1): 337-43.
- Borker, S.G., Shenoy, D.M., Bepari, F., Kurian, S., Uskaikar, H. 2022. Variation of biogenic sulphur compounds in the estuarine and coastal waters of Goa, West coast of India. *Indian Journal of Geo-Marine Sciences*, 51(6): 517-528.
- Chowdhury, M., Biswas, H., Silori, S., Sharma, D., Winter, A. 2022. Distribution of extant coccolithophores from the northwest continental shelf of India during the summer monsoon, *Phycologia*, 61 (3): 1-15.
- Elizabeth, A.I., Effy, J.B., Francis, P.A. 2022. On the upper ocean response of Bay of Bengal to very severe cyclones Phailin and Hudhud. *Journal of Operational Oceanography*, 15(1): 17-31.
- Fadnavis, S., Chavan, P., Joshi, A., Sonbawne, S. M., Acharya, A., Devara, P.C.S., Rap, A., Ploeger, F., Müller, R. 2022. Tropospheric warming over the northern Indian Ocean caused by South Asian anthropogenic aerosols: possible impact on the upper troposphere and lower stratosphere. *Atmospheric Chemistry and Physics*, 22: 7179–7191.
- George, J.V., Naik, R.K., Anilkumar, N., Sabu, P., Patil, S.M., Mishra, R.K. 2022. Physical control on the inter-annual variability of summer dissolved nutrient concentration and phytoplankton biomass in the Indian sector of the Southern Ocean. *Oceanologia*, 64(4): 675-693.
- Ghosh, J., Chakraborty, K., Bhattacharya, T., Valsala, V., Baduru, B. 2022. Impact of coastal upwelling dynamics on the pCO₂ variability in the southeastern Arabian Sea. *Progress in Oceanography*, 203: 102785.
- Hulswar, S., Simó, R., Galí, M., Bell, T.G., Lana, A., Inamdar, S., Halloran, P.R., Manville, G., and Mahajan, A. S.: Third revision of the global surface seawater dimethyl sulfide climatology (DMS-Rev3). *Earth System Science Data*, 14: 2963–2987.
- Hulswar, S., Mohite, P., Mahajan, A. 2022. Quantifying stratospheric ozone loss over Antarctica in the last two decades using corrected satellite profiles. *Polar Science*, 33: 100860.
- Jawak, S.D., Wankhede, S. F., Luis, A.J., Balakrishna, K., 2022. Impact of image-processing routines on mapping glacier surface facies from Svalbard and the Himalayas using pixel-based methods. *Remote Sensing*, 14(6): 1414.
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- Jena, B., Bajish, C.C., Turner, J., Ravichandran, M., Anilkumar, N., Kshitija, S. 2022. Record low sea ice extent in the Weddell Sea, Antarctica in April/May 2019 driven by intense and explosive polar cyclones. *Npj Climate and Atmospheric Science*, 5(1): 19.
- Jena, B., Bajish, C.C., Turner, J., Ravichandran, M., Kshitija, S., Anilkumar, N., Singh, A.K., Pradhan, P.K., Ray, Y., Saini, S., 2022. Mechanisms associated with the rapid decline in sea ice cover around a stranded ship in the Lazarev Sea, Antarctica. *Science of the Total Environment*, 821: 153379.
- Karmakar, N., Joseph, S., Sahai, AK. 2022. Northward propagation of convection over Arabian Sea and Bay of Bengal: a perspective from vorticity equation. *Climate Dynamics* 59 (9-10), 2751-2767.
- Khan, M.A., Rahman, A., Sahoo, D., Saxena, H., Singh, A., Kumar, S. 2022. Nitrous oxide in the central Bay of Bengal during the summer monsoon. *Regional Studies in Marine Science*, 52(6239):102314.
- Kerker, A.U., Tripathy, S.C., Pandi, S.R. 2022. Bio-optical depiction of a polar ocean under a global change: exploring the regional absorption traits. *Global and Planetary Change*, 213: 103818.
- Kumar, H., Tiwari, C. 2022. Climatology, trend of aerosol-cloud parameters and their correlation over the Northern Indian Ocean. *Geoscience Frontiers*, 14(4): 101563.

- Kumari, V.R., Ghosh, V.R.D., Rao, D.N., Krishna, M.S., Sarma, V.V.S.S. 2022. Nitrogen fixation in the western coastal Bay of Bengal: Controlling factors and contribution to primary production. *Regional Studies in Marine Science*, 53: 102410.
- Kumari, V.R., Neeraja, B., Rao, D.N., Ghosh, V.R.D., Rajula, G.R., Sarma, V.V.S.S. 2022. Impact of atmospheric dry deposition of nutrients on phytoplankton pigment composition and primary production in the coastal Bay of Bengal. *Environmental Science and Pollution Research*, 29(54): 82218-82231.
- Kumari, V.R., Sarma, V.V.S.S., Kumar, M.D. 2022. Spatial variability in aerosol composition and its seawater acidification potential in coastal waters of the western coastal Bay of Bengal. *Journal of Earth System Science*, 131(4): 251.
- Kushwaha, V.K., PrasannaKumar, S., Feba, F., Karumuri, A. 2022. Findlater jet induced summer monsoon memory in the Arabian Sea. *Scientific Reports*, 12: 13037.
- Luis, A.J., Alam, M., Jawak, S.D. 2022. Spatiotemporal change analysis for snowmelt over the Antarctic ice shelves using scatterometers. *Frontiers in Remote Sensing*, 3.
- Luis A.J., Lotlikar, V. 2022. Hydrographic characteristics along two XCTD sections between Africa and Antarctica during austral summer 2018. *Polar Science*, 30: 100705.
- Luis, A.J., Tomar, K.S., Prasad, A. 2022. Hydrodynamics of the choke point between Cape Town and Antarctica during the austral summer of 2019. *Deep-Sea Research*, 167: 103424.
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- Nayak, A.A., Vinayachandran, P.N., George, J.V., 2022. Turbulent dissipation rates across the Summer Monsoon Current. *Ocean Dynamics*, 72 (9-10): 695-714.
- Panda, P.P., Aswini, M.A., Bhatt, P., Srimuruganandam, B., Peketi, A., Kumar, A. 2022. Bioactive Trace Elements' Composition and Their Fractional Solubility in Aerosols from the Arabian Sea during the Southwest Monsoon. *ACS Earth and Space Chemistry*, 6 (8): 1969-1981.
- Pandi, S.R., Tripathy, S.C., Parida, C., Lotliker, A.A., Naik, R.C.S., Naik, R.K., Mishra, R.K., Anilkumar, N., 2022. Spatiotemporal variability in bio-optical characteristics of the Southwestern Tropical Indian Ocean during Boreal Summer: Biophysical influences. *Progress in Oceanography*, 208:102883.
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- Sharma, D., Biswas, H., Panda, P.P., Chowdhury, M., Silori, S., Pandey, M., Kaushik, A., Kumar, A. 2022. Atmospheric dust addition under elevated CO₂ restructured phytoplankton community from the Arabian Sea: A microcosm approach. *Marine Chemistry*, 247: 104183.
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- Silori, S., Biswas, H., Chowdhury, M., Sharma, D., Mandeng-Yogo, M., Cardinal, D. 2022. Interannual variability in particulate organic matter distribution and its carbon stable isotope signatures from the western Indian shelf waters. *Science of the Total Environment*, 844: 157044.
- Singh, V.K., Roxy, M.K. 2022. A review of the ocean-atmosphere interactions during tropical cyclones in the north Indian Ocean. *Earth-Science Reviews*, 226: 103967.

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- Sridevi, B., Sarma, V.V.S.S. 2022. Enhanced Atmospheric Pollutants Strengthened Winter Convective Mixing and Phytoplankton Blooms in the Northern Arabian Sea. *Journal of Geophysical Research: Biogeosciences*, 127(10): e2021JG006527.
- Suresh, K., Kumar, A., Ramaswamy, V., Prakash Babu, C. 2022. Seasonal variability in aeolian dust deposition fluxes and their mineralogical composition over the Northeastern Arabian Sea. *International Journal of Environmental Science and Technology* 19 (8): 7701-7714.
- Swapna, P., Sreeraj, P., Nayanasetti, S., Jyoti, J., Krishnan, R., Prajeesh, A.G., Ayantika, D.C., Singh, M. 2022. Increasing frequency of extremely severe cyclonic storms in the north Indian Ocean by anthropogenic warming and southwest monsoon weakening. *Geophysical Research Letters*, 49: 1-11.
- Tripathy, S.C. 2022. Bio-optical characteristics in relation to phytoplankton composition and productivity in a twin Arctic fjord ecosystem during summer. Chapter 13 in N. Khare (Ed): *Climate Change in the Arctic: An Indian Perspective*, Taylor & Francis, CRC Press, e-ISBN: 9781003265177, 386.
- Venkataramana, V., Kerkar, A.U., Mishra, R.K., Sabu, P., Anilkumar, N., 2022. Hydrodynamics and zooplankton assemblages in the Prydz Bay, East Antarctica, during the austral summer of 2017. *Regional Studies in Marine Science*, 52: 102341.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2022? If yes, who? How did you engage?

PART 2 - Planned activities for 2023 and 2024

1. Planned major national and international field studies and collaborative laboratory and modelling studies (incl. all information possible, dates, locations, teams, work, etc.).

Expeditions in the Arabian Sea, Bay of Bengal and Indian Ocean have been planned for undertaking research on various aspects viz., biogeochemistry of trace elements and isotopes, ocean acidification along east coast of India and assessing carbon budget in the Southern Ocean. Research cruise details of MoES research vessels can be availed at: <https://ncpor.res.in/pages/view/248-research-vessel-moment>.

- The 43rd Indian Scientific Expedition to Antarctica has been proposed to be held in December 2023 for field data collection in the Southern Ocean.
- PRAISE Field Survey for 2023-24 will be carried out.
- A project has been proposed between NCPOR and Goa University to study the impact of rapid warming on heterotrophic bacterial metabolic rates and the trophic link to zooplankton and their contributory role in the carbon cycle in Arctic Kongsfjorden-Svalbard.
- Development of ground and satellite based remote sensing capabilities for retrieval and validation of sea ice variables, specifically sea ice motion and sea ice thickness have been proposed by scientists at NCPOR in collaboration with University of Manitoba and the BAS, UK.

2. Events like conferences, workshops, meetings, summer schools, capacity building etc. (incl. all information possible).

- Scientific session entitled "Plankton diversity, food web dynamics and biogeochemical cycle in the Southern Ocean" has been proposed to be conducted at the first Southern Ocean Observing System (SOOS) Symposium will that will be held from 14-18 August 2023 in Hobart, Tasmania.

3. Funded national and international projects/activities underway.

A number of studies funded by various Government agencies viz., Ministry of Earth Sciences (MoES), Council of Scientific and Industrial Research (CSIR), Ministry of Human Resource and Development, Department of Science and Technology, Indian Space Research Organisation (ISRO) are underway.

- Scientific projects under Polar Science and Cryosphere Research (PACER) programme: Hydrodynamics of the Indian Sector of Coastal Antarctica is funded by MoES (MoES/EFC-NCAOR/PACER/05/2018 PC-1).
- Climate Relevant Interactions and feedbacks- key role of sea ice and snow in the polar and global climate system (CRiceS) is funded by MoES.

4. Plans / ideas for future national or international projects, programmes, proposals, etc. (please indicate the funding agencies and potential submission dates).

- MoES and the European Union (EU) Joint Calls for Research Projects: HORIZON-CL6-2023-CLIMATE-01-8: Closing the research gaps on Essential Ocean Variables (EOVs) in support of global assessments. Deadline: 12th April 2023.
- Part of the International Kongsfjorden Year (IKY) project proposal has been submitted for funding from Norwegian Research Council.
- Project proposals have been submitted to MoES in collaboration with CSIR-CSMCRI and Presidency University, Kolkata under the Deep Ocean Mission (DOM). The proposals are focussed to explore the marine biotechnological/microbiological and benthic fauna-related studies vis-à-vis anthropogenic influences and climate change.

5. Engagements with other international projects, organisations, programmes, etc.

- An international collaboration with NCPOR and British Antarctic Survey was developed under Drivers and Effects of Fluctuations in sea Ice in the ANTArctic (DEFIANT) project (December 2021 – November 2025).
- Researchers at NCPOR are part of a European Union (EU) funded project 'Climate Relevant Interactions and feedbacks- key role of sea ice and snow in the polar and global climate system (CRiceS)'.
- Dr. Anil Kumar, Scientist-G & Group Director (Ocean Sciences) at NCPOR is an associate Member, SCOR Working Group 160 for analyzing ocean turbulence observations to quantify mixing (ATOMIX).
- Dr. Ashwini Kumar, Senior Scientist, CSIR-NIO, Goa was appointed as a member of the New SCOR Working Group 167, Reducing Uncertainty in Soluble Aerosol Trace Element Deposition (RUSTED).

Comments