surface ocean solas lower atmosphere study

Report for the year 2020 and future activities

SOLAS India

Compiled by: Sheryl Oliveira Fernandes and Anoop Mahajan

This report has two parts:

***- Part 1:** reporting of activities in the period of January 2020 - Jan/Feb 2021*
***- Part 2:** reporting on planned activities for 2021 and 2022.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies of high sensitivity systems;
Environmental impacts of geoengineering;
Science and society**.**

***IMPORTANT**: This report should reflect the efforts of the SOLAS community in the **entire country** you are representing (all universities, institutes, lab, units, groups, cities).*

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

A mailing list for the SOLAS India scientific community could be initiated to facilitate specific requests/announcements. Inputs received from various researchers would be immensely helpful in updating and compiling research publications, projects; field campaigns; workshops and conferences; international collaborations, etc.

PART 1 - Activities from January 2020 to Jan/Feb 2021

1. Scientific highlight

*Describe one scientific highlight with a title, text (**max. 300 words**), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in results of international collaborations. (If you wish to include more than one highlight, feel free to do so).*

Title: Surface Inorganic Iodine Speciation in the Indian and Southern Oceans From 12°N to 70°S

Text: Marine iodine speciation can be used as a tracer for primary productivity, sedimentary inputs, and ocean oxygenation. The reaction of iodide with ozone at the sea surface has also been identified as the largest deposition sink for tropospheric ozone and the dominant source of iodine to the atmosphere. Accurate incorporation of these processes into atmospheric models requires improved understanding of iodide concentrations at the air-sea interface and help with better estimation of the sea-air iodine fluxes. However, observations of sea surface iodide are relatively sparse and were particularly lacking in the Indian Ocean basin. A new study by Chance et al (2020) added sea surface (10 m depth) iodide and iodate observations made during four cruises in the Indian Ocean and the Indian sector of the Southern Ocean to the global database. These observations span a large latitudinal transect from ~12ºN to ~70ºS. Concentrations and spatial distribution of sea surface iodide follow the same general trends as in other ocean basins, with iodide concentrations tending to decrease with increasing latitude (and decreasing sea surface temperature). However, the gradient of this relationship was steeper in subtropical waters of the Indian Ocean than in the Atlantic or Pacific, suggesting that it might not be accurately represented by widely used parameterisations based on sea surface temperature. This difference in gradients between basins may arise from differences in phytoplankton community composition and/or iodide production rates. Iodide concentrations in the tropical northern Indian Ocean were higher and more variable than elsewhere. Modelling based analysis showed that multiple interacting factors were found to drive the iodide distribution. These observations have also been used by other groups to understand atmospheric iodine distribution in the Indian Ocean, showing that the current global parameterizations are inadequate for explaining the sea-air flux of iodine compounds (Inamdar et al., 2020).

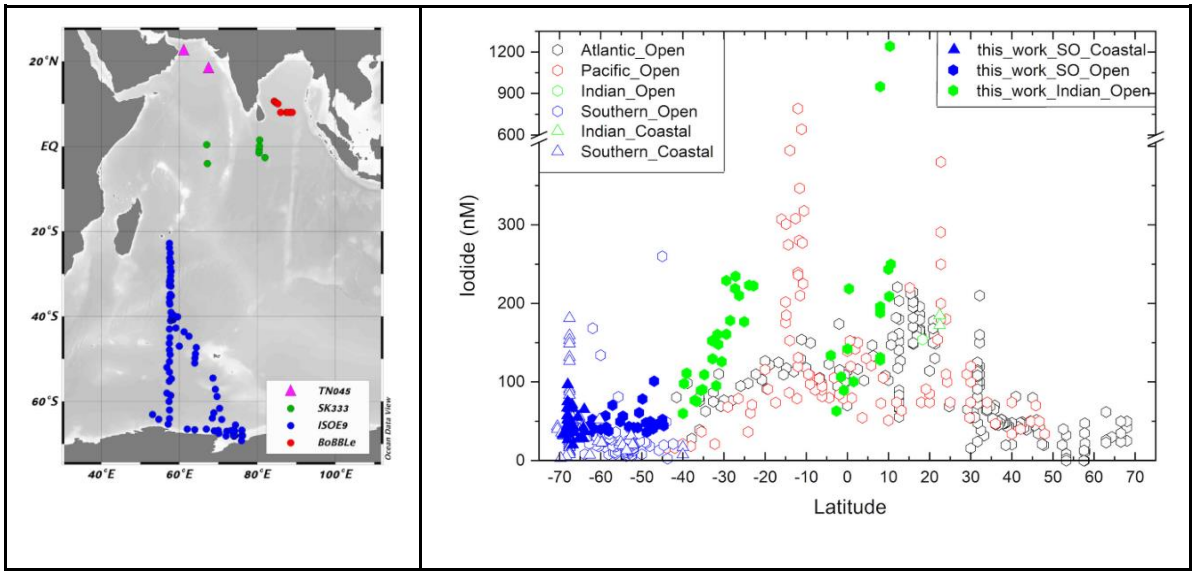

Figure: Observations from four different cruises in the Indian Ocean were integrated into a global seawater iodine species database. These are the first observations in the Indian Ocean, and help plug a major gap in the current database.

Citations:

Chance R., Liselotte T., Sarkar A., Sinha A.K., Mahajan A.S., Chacko R., Sabu P., Roy R., Jickells T.D., Stevens D., Wadley M., Carpenter L.C. (2020). Surface Inorganic Iodine

Speciation in the Indian and Southern Oceans From 12°N to 70°S. Frontiers in Marine Science, 621(7): 1-16. DOI: 10.3389/fmars.2020.00621.

Inamdar S., Tinel L., Chance R., Carpenter L.J., Sabu P., Chacko R., et al. (2020). Estimation of Reactive Inorganic Iodine Fluxes in the Indian and Southern Ocean Marine Boundary Layer. Atmospheric Chemistry and Physics, 20(20): 12093-12114. DOI: 10.5194/acp-20-12093-2020.

2. Activities/main accomplishments in 2020 (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).

Meeting

SOLAS Indian Ocean meeting, 30 September 2020, Online (Conveners: A. Mahajan, H. Bange, J. Gier, L. Miller, P. Suntharalingam).

3. Top 5 publications in 2020 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Aswini M.A., Kumar A., Das S.K. 2020. Quantification of long-range transported aeolian dust towards the Indian peninsular region using satellite and ground-based data - A case study during a dust storm over the Arabian Sea. Atmospheric Research, 239: 104910. DOI: 10.1016/j.atmosres.2020.104910.

Chance R., Liselotte T., Sarkar A., Sinha A.K., Mahajan A.S., Chacko R., Sabu P., Roy R., Jickells T.D., Stevens D., Wadley M., Carpenter L.C. 2020. Surface inorganic iodine speciation in the Indian and Southern oceans from 12°N to 70°S. Frontiers in Marine Science, 621(7): 1-16.. DOI: 10.3389/fmars.2020.00621.

Praveen V., Valsala V., Ajayamohan R.S., Balasubramanian S. 2020. Oceanic mixing over the Northern Arabian Sea in a warming scenario: Tug of war between wind and buoyancy forces. Journal of Physical Oceanography, 50: 945-964. DOI: 10.1175/JPO-D-19-0173.1.

Tejas D.M., Gnanaseelan C., Rashmi A.K., Deepa J.S. 2020. Indian Ocean warming trends and forcing mechanism with emphasis on northeastern tropical Indian Ocean. In: Sheela Nair L., Prakash T.N., Padmalal D., Kumar Seelam J. (eds.), Oceanic and Coastal Processes of the Indian Seas. Journal of Coastal Research, 89: 15-19. DOI: 10.2112/SI89-003.1.

Tripathi N., Sahu L.K., Singh A., Yadav Ravi, Patel A., Patel K., Meenu P. 2020. Elevated levels of biogenic nonmethane hydrocarbons in the marine boundary layer of the Arabian Sea during the intermonsoon. Journal of Geophysical Research: Atmospheres, 125: 22, e2020JD032869. DOI: 10.1029/2020JD032869.

Vibhute A., Halder S., Prem Singh, Parekh A., Chowdary J.S., Gnanaseelan C. 2020. Decadal variability of tropical Indian Ocean sea surface temperature and its impact on the Indian summer monsoon. Theoretical and Applied Climatology, 141(1-2): 551-566. DOI: 10.1007/s00704-020-03216-1.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2020? If yes, who? How did you engage?

Engagement with stakeholders/societal partners/external research users was planned to co-produce knowledge in 2020. However, due to the prevailing COVID-19 pandemic it could not be initiated.

PART 2 - Planned activities for 2021 and 2022

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

1. A manuscript synthesizing SOLAS activities in the Indian Ocean is currently underway.
2. Expeditions in the Arabian Sea, Bay of Bengal and Indian Ocean have been planned onboard ORV *Sagar Kanya* and other chartered scientific vessel(s).

Some of the cruises scheduled onboard of ORV *Sagar Kanya* from April 2021 to March 2022 are as follows:

- Cruise in Arabian Sea to study the influence of seabed features & open ocean exchanges on coastal ocean dynamics; 1 April to 10 May 2021; PI: Dr. L Sheela Nair.
- The Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) cruise in Bay of Bengal; 15 May to 3 June 2021; PIs: Dr A. Chatterjee / Dr Suresh K.
- OOS RAMA cruise in Indian Ocean/ Arabian Sea; 8 June to 10 July 2021; PI: Dr. R. Venkatesan.
- Cruise in Arabian Sea/Bay of Bengal; 18 Aug to 16 Sept 2021; PI: Dr. R. Venkatesan.
- Cruise in Arabian Sea to study Biogeochemistry of trace elements and isotopes; 20 Oct to 18 Nov 2021; PIs: Dr. A K Sudheer and Prof. Ravi Bhushan.
- Cruise in Bay of Bengal to study ocean acidification along East coast; 22 Dec 2021 to 11 Jan 2022; PI: Dr VVSS Sarma.

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

Due to the ongoing COVID-19 pandemic, the International Indian Ocean Science Conference (IIOSC)-2020 has been postponed till further notice.

3. Funded national and international projects/activities underway.

A number of studies funded by various Government agencies in India and overseas viz., Ministry of Earth Sciences (MoES), Council of Scientific and Industrial Research (CSIR), Ministry of Human Resource and Development, Department of Science and Technology, Space Applications Centre, ISRO, Texas A&M University, Texas, USA and Sri Venkateswara University, Tirupati, India and Office of Naval Research (ONR), Department of Defense, USA have been carried out and are as follows:

Anandh T.S., Das BK., Kuttippurath J., Chakraborty A. 2020. A coupled model analyses on the interaction between oceanic eddies and tropical cyclones over the Bay of Bengal. Ocean Dynamics, 70(3): 327-337. DOI: 10.1007/s10236-019-01330-x.

Anju E.I., Effy J.B., Francis P.A. 2020. On the upper ocean response of Bay of Bengal to very severe cyclones Phailin and Hudhud. Journal of Operational Oceanography, DOI: 10.1080/1755876X.2020.1813412.

Beal L.M., Vialard J., Roxy M.K., et al. 2020. A roadmap to IndOOS-2: Better observations of the rapidly-warming Indian Ocean. Bulletin of the American Meteorological Society, 101: E1891-

E1913. DOI: 10.1175/BAMS-D-19-0209.1.

Dandapat S., Gnanaseelan C., Parekh A. 2020. Impact of excess and deficit river runoff on Bay of Bengal upper ocean characteristics using an ocean general circulation model. Deep Sea Research Part II, 172:104714. DOI: 10.1016/j.dsr2.2019.104714.

Greaser S.R., Subrahmanyam B., Trott C.B., Roman-Stork H.L. 2020. Interactions between mesoscale eddies and synoptic oscillations in the Bay of Bengal during the strong monsoon of 2019. Journal of Geophysical Research-Oceans, 125(10): e2020JC016772, DOI: 10.1029/2020JC016772.

Hrudya, P.P.V.H., Varikoden H., Vishnu R.N. 2020. Changes in the relationship between Indian Ocean dipole and Indian summer monsoon rainfall in early and recent multidecadal epochs during different phases of monsoon. International Journal of Climatology, 41(S1): E305-E318. DOI: 10.1002/joc.6685.

Karmakar N., Chakraborty A., Nanjundiah R.S. 2020. Influence of global sea-surface temperature on ultra-low-frequency variability in Indian summer monsoon rainfall. Quarterly Journal of the Royal Meteorological Society. 146(727): 904-921. DOI: 10.1002/qj.3715.

Kumar V., Pradhan P.K., Sinha T., Rao S.V.B., Chang H-P. 2020. Interaction of a low-pressure system, an offshore trough, and mid-tropospheric dry air intrusion: The Kerala Flood of August 2018. 11, 740. DOI: 10.3390/atmos11070740.

Pant V., Prakash K.R. 2020. Response of air–sea fluxes and oceanic features to the coupling of ocean–atmosphere–wave during the passage of a tropical cyclone. Pure and Applied Geophysics. 177, 3999–4023. DOI: 10.1007/s00024-020-02441-z

Pokhrel S., Dutta U., Rahaman H., Chaudhari H.S., Hazra A., Saha Subodh K., Veeranjaneyulu C. 2020. Evaluation of different heat flux products over the Tropical Indian Ocean. Earth and Space Science, 7(6): e2019EA000988, DOI: 10.1029/2019EA000988.

Roy C., Fadnavis S., Sabin T.P. 2020. The stratospheric ozone rich cold intrusion during El-Niño over the Indian region: implication during the Indian summer monsoon. International Journal of Climatology. 41(S1): E233-E248. DOI: 10.1002/joc.6680.

Sharma R., Agarwal N., Chakraborty A., Mallick S., Kumar R. 2020. Assessing the ocean surface current impact on scatterometer (C- and Ku-Bands) and altimeter (Ka-Band) derived winds in the Bay of Bengal. IEEE Geoscience and Remote Sensing Letters, DOI: 10.1109/LGRS.2020.3025817.

Singh V.K., Roxy M.K., Deshpande M. 2020. The unusual long track and rapid intensification of very severe cyclone Ockhi. Current Science, 119(5): 771-779, DOI: 10.18520/cs/v119/i5/771-779.

Subrahmanyam B., Roman-Stork H.L., Murty V.S.N. 2020. Response of the Bay of Bengal to 3-7-day synoptic oscillations during the Southwest monsoon of 2019. Journal of Geophysical Research-Oceans, 125: e2020JC016200. DOI: 10.1029/2020JC016200.

Sudeepkumar B.L, Babu C.A., Varikoden H. 2020. Atmospheric Boundary Layer Height and Surface Parameters: Trends and Relationships over the West Coast of India. Atmospheric Research, 245: 105050. DOI: 10.1016/j.atmosres.2020.105050.

Tripathi N., Sahu L.K., Singh A., Yadav Ravi, Karati K.K. 2020. High levels of isoprene in the marine boundary layer of the Arabian Sea during spring inter-monsoon: Role of phytoplankton blooms. ACS Earth and Space Chemistry 4, 4, 583–590. DOI:

10.1021/acsearthspacechem.9b00325.

Yadav K, Sarma VVSS, Kumar MD. 2020. Spatial and temporal variability in concentration and characteristics of aerosols at Visakhapatnam (east) and Goa (west) coasts of India. Environmental Science and Pollution Research, 27: 532-546. DOI: 10.1007/s11356-019-06784-6.

These studies fall within the scope of SOLAS. Therefore, a request will be made to endorse them under SOLAS.

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

Compilation of previous cruise/project reports has been initiated.

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

Projects endorsed by IIOE-2 are as follows:

Sr. no.	Project no.	Project title	Lead investigator and contact details	Period of project
1.	IIOE2-EP12	Dust Stimulated Nitrogen Fixation in the Arabian Sea- an assessment of HNLC region hypothesis (DUSTNIF)	Dr. Arvind Singh, PRL, Ahmedabad, India. arvinds@prl.res.in	2016-2020
2.	IIOE2-EP16	Biogeochemistry of Trace Elements and Isotopes in the Indian Ocean (GEOTRACES-INDIA)	Dr. Sunil Kumar Singh, Physical Research Laboratory, Ahmedabad 380009, India sunil@prl.res.in	April 2011-continuing
3.	IIOE2-EP17	Real-time Meteorological and Oceanographic data collection	Dr. R. Venkatesan, NIOT, Chennai, India	1996-continuing

		using moored buoy network in Indian Seas (OON-INDIA)	venakt@niot.res.in	
4.	IIOE2-EP23	Influence of Indian Ocean sector of the Southern Ocean dynamics and biogeochemistry on the tropical weather and climate (ISESO)	Dr. Anil Kumar N, NCAOR, Goa 403 804, India anil@ncaor.gov.in	2002-continuing

Comments