

Report for the year 2023 and future activities

SOLAS Finland

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This report has two parts:

- **Part 1:** reporting of activities in the period of January 2023 - Feb/Mar 2024
- **Part 2:** reporting on planned activities for 2024 and 2025.

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 Core Themes or Cross-Cutting Themes.

Core Theme 1: Greenhouse gases and the oceans;

Core Theme 2: Air-sea interfaces and fluxes of mass and energy;

Core Theme 3: Atmospheric deposition and ocean biogeochemistry;

Core Theme 4: Interconnections between aerosols, clouds, and marine ecosystems;

Core Theme 5: Ocean biogeochemical control on atmospheric chemistry;

Cross-Cutting Theme: Integrated studies of high sensitivity systems (upwelling systems, Indian Ocean, polar oceans and sea ice);

Cross-Cutting Theme: Climate intervention;

Cross-Cutting Theme: Science and society.

IMPORTANT: *This report should reflect the efforts of the SOLAS community in the entire country or region 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 need has arisen to link air quality studies with those of water quality. However, emission inventories for air emissions do not necessarily contain relevant pollutant species especially for the contaminants. For air, it is relevant to model NO_x, SO_x, PM, and few metals (Cd, Pb) etc, but contaminants are not usually covered since these are not listed in the LRTAP convention as monitored species. PAHs, their alkylated forms and many more metals are relevant from water point of view, but emission/discharge inventories for these do not exist or they are for individual

sites. Therefore, it would be useful to develop a similar service of water discharge inventories as exists within Copernicus Atmospheric Monitoring Services for air emissions. This could be done under Copernicus marine, and it would enable studies of water quality everywhere in Europe. The need to understand the contaminants is very visible in the HELCOM HOLAS3 (Baltic Marine Environment Protection Commission/Holistic Assessment 3) report, which listed contaminants as the primary environmental concern over eutrophication.

PART 1 - Activities from January 2023 to Feb/Mar 2024

1. Scientific highlight

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2. Activities/main accomplishments in 2023 (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).

Projects

- Kristian Spilling from SYKE coordinate an Academy of Finland funded PHYTOTRANS-project which will unravel the interplay between the phytoplankton community composition vertical and lateral particle transport on the organic matter remineralization in coastal seas, to better understand the coastal carbon sink. **Themes #1, #5**
- SYKE is participating in SapHTies (Metrology for standardized seawater pH_T measurements) and MINKE (Metrology for integrated marine management and knowledge transfer network) EU-projects addressing metrological challenges for the measurement of seawater acidity. Projects have included interlaboratory comparisons and sensor comparisons for pH measurements. **Theme #1**
- In the EU-project NAUTILUS (New approach to underwater technologies for innovative, low-cost ocean observation) SYKE is testing low-cost pH sensor for FerryBox applications. **Theme #1**
- Project “Baltic Carbon” coordinated by Jukka Seppälä from SYKE and funded by Finnish Ministry of Environment. provided a list of recommendations how to organize a high resolution and impactful carbonate system monitoring of the Finnish waters in the Baltic Sea. **Themes #1, #5**
- Jukka-Pekka Jalkanen from FMI is the coordinator of the H2020/EMERGE project on the environmental impacts of shipping emissions. **Themes #3, Science and Society**

Field campaigns

- At Utö Marine station, joint continuous and high-frequency measurements with FMI and SYKE were ongoing approx. 60% of the year, including in-water pCO₂ and pH, as well as relevant physical, chemical, and biological measurements to understand their impact on carbonate system variability. **Themes #1, #2.**
- Joonas Virtasalo from GTK participated in the Science Party of IODP Expedition 386 Japan Trench Paleoseismology. **Theme #5**

Workshops and conferences

- Sami Kielosto and Lari Kaukonen from SYKE participated in MINKE “pHT Interlaboratory Comparison on buffered artificial seawater and natural seawater “at MIO – AMU, Marseille, from the 13th to the 17th of November 2023. **Theme #1.**
- Martti Honkanen from FMI participated with a poster in the 14th Baltic Sea Science Congress (BSSC) in Helsinki, Finland. **Theme #1.**
- Martti Honkanen from FMI had an oral presentation in the FINMARI (Finnish Marine Research Infrastructure) Researcher Day 2023 in Helsinki, Finland. **Theme #1.**
- Scientists from FMI participated in the Joint Transport and Air Pollution & Shipping and Environment conference in Gothenburg. FMI was included in 16 conference abstracts of TAP&SEAssistance for EMSA/EEA with the 2nd European Maritime Transport Environmental Report through EMERGE and CAMS2-61 project data deliveries. **Themes #3, Sciences and Society.**

Working group and committees

- Jukka-Pekka Jalkanen from FMI participated in the ICES WGSHP (ICES Working Group on Shipping Impacts in the Marine Environment) work. **Themes #3, Science and society.**
- Aarno Kotilainen from GTK is a member, Joonas Virtasalo from GTK and Petteri Uotila from HU are deputy members in the committee for the planning of the Finnish national Implementation Plan for the UN Decade of Ocean Science. **All themes.**
- Petteri Uotila from University of Helsinki is the Chair and Heidi Pettersson from FMI the vice chair of the Finnish National Committee of SCOR. **Themes 1-5**
- Heidi Pettersson from FMI is the Finnish National Correspondent of IAPSO/IUGG. **Themes 1,2, Cross-cutting themes**
- Joonas Virtasalo from GTK is the Finnish national delegate in ESSAC (Science committee of ECORD, European Consortium for Ocean Research Drilling), the European branch of IODP. **Themes Climate intervention, Science and society.**

Reports, assessments, etc

- Jukka-Pekka Jalkanen from FMI produced two IMO submissions from EMERGE project (MEPC 81/INF.21 and PPR 11/INF.11), to support the Finnish delegation on the issue of exhaust gas cleaning systems. These were accompanied with a large report published in Jan 2024. **Themes #3, Science and society.**
- Jukka-Pekka Jalkanen from FMI produced three reports to HELCOM IG Maritime 2023 (air emissions, discharges, noise from Baltic Sea shipping) and Heidi Pettersson from FMI a report on the Baltic Sea wave climate to HELCOM BSEFS 2023. **Themes #2, #3, Science and society.**

Data

- Atmospheric GHG measurements at Tvärminne Zoological Station of HU were approved with an ICOS (Integrated Carbon Observation System) station label for Associated Ecosystem station (https://meta.icos-cp.eu/resources/stations/ES_FI-Tvm), Currently the ocean station is under development. **Theme #1**
- The ICOS OTC (Integrated Carbon Observation System/Ocean Thematic Center) labelling process of the pCO₂ measurement on M/S Silja Serenade ferrybox

travelling between Helsinki and Stockholm is progressing and new equipment will be acquired. **Theme #1.**

- FMI continued delivery of ship emissions products for Copernicus Atmosphere Monitoring Systems (CAMS2-61) for global and regional emissions. **Themes #3, Science and society.**

International collaborations

- Jukka Seppälä from SYKE has been collaborating with Hellenic Centre for Marine Research (Greece) on their high-frequency observations of carbonate system. **Themes #1, #5**
- Lumi Haraguchi from SYKE has been collaborating with University of Cape Town (South Africa) on Atlantic Southern Ocean productivity and carbon export. **Themes #1, #5**

3. Publications in 2023 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

- Aakko-Saksa, P.T., Lehtoranta, K., Kuittinen, N., Järvinen, A., Jalkanen, J.-P., Johnson, K., Jung, H., Ntziachristos, L., Gagné, S., Takahashi, C., Karjalainen, P., Rönkkö, T., Timonen, H. (2023) Reduction in greenhouse gas and other emissions from ship engines: Current trends and future options, *Progress in Energy and Combustion Science* 94, 101055. <https://doi.org/10.1016/j.pecs.2022.101055> **Themes #3, Science and society.**
- Arévalo-Martínez, D.L., Haroon, A., Bange, H.W., Erkul, E., Jegen, M., Moosdorf, N., Schneider von Deimling, J., Berndt, C., Böttcher, M.E., Hoffmann, J., Liebetrau, V., Mallast, U., Massmann, G., Micallef, A., Michael, H.A., Paasche, H., Rabbel, W., Santos, I., Scholten, J., Schwalenberg, K., Szymczycha, B., Thomas, A.T., Virtasalo, J.J., Waska, H., Weymer, B. (2023) Ideas and perspectives: land-ocean connectivity through groundwater. *Biogeosciences* 20, 647–662. **Theme #5**
- Broman, E., Barua, R., Donald, D., Roth, F., Humborg, C., Norkko, A., Jilbert, T., Bonaglia, S., Nascimento, F.J.A. (2023) No evidence of light inhibition on aerobic methanotrophs in coastal sediments using eDNA and eRNA. *Environmental DNA*, 5:766-781. **Theme #1**
- Chu, M., Bao, R., Strasser, M., Ikehara, K., Everest, J., Maeda, L., Hochmuth, K., Xu, L., McNichol, A., Bellanova, P., Rasbury, T., Kölling, M., Riedinger, N., Johnson, J., Luo, M., März, C., Straub, S., Jitsuno, K., Brunet, M., Cai, Z., Cattaneo, A., Hsiung, K., Ishizawa, T., Itaki, T., Kanamatsu, T., Keep, M., Kioka, A., McHugh, C., Micallef, A., Pandey, D., Proust, J.N., Satoguchi, Y., Sawyer, D., Seibert, C., Silver, M., Virtasalo, J., Wang, Y., Wu, T.-W. & Zellers, S. (2023): Earthquake-enhanced dissolved carbon cycles in ultra-deep ocean sediments. *Nature Communications* 14, 5427. **Theme #5**
- Fink, L., Karl, M., Matthias, V., Oppo, S., Kranenburg, R., Kuenen, J., Moldanova, J., Jutterström, S., Jalkanen, J.-P., Majamäki, E. (2023) Potential impact of shipping on air pollution in the Mediterranean region: a multimodel evaluation: comparison of photooxidants NO₂ and O₃, *Atmos. Chem. Phys.*, 23, 1825-1862, <https://doi.org/10.5194/acp-23-1825-2023>. **Themes #3, Science and society.**
- Fink, L., Karl, M., Matthias, V., Oppo, S., Kranenburg, R., Kuenen, J., Jutterström, S., Moldanova, J., Majamäki, E., and Jalkanen, J.-P. (2023) A multimodel evaluation of the potential impact of shipping on particle species in the Mediterranean Sea, *Atmos. Chem. Phys.*, 23, 10163–10189, <https://doi.org/10.5194/acp-23-10163-2023>. **Themes #3, Science and society.**

- Flynn, R.F., Haraguchi, L., McQuaid, J., Burger, J.M., Lunga, P.M., Stirnimann, L., Samanta, S., Roychoudhury, A.N., Fawcett, S.E. (2023) Nanoplankton: The dominant vector for carbon export across the Atlantic Southern Ocean in spring. *Sci. Adv.* **9**, eadi3059(2023). DOI:10.1126/sciadv.adi3059. **Themes #1, #5**
- Haraguchi, L., Gonçalves-Araujo, R., Stedmon, C.A. (2024) A Sea of Carbon. *Front. Young Minds.* 12:1150384. doi: 10.3389/frym.2023.1150384. **Themes #1, #5**
- Heikkilä, M., Jalkanen, J-P. (2023) The association between vessel departures and air pollution in Helsinki port area 2016–2021, *Atmosphere*, **14**(4), 757. <https://doi.org/10.3390/atmos14040757>. **Themes #3, Science and society.**
- Jalkanen, J-P., Majamäki, E., Heikkilä M., Johansson, L. (2023) "Emissions from Baltic Sea shipping in 2022", Submission from Finland to HELCOM Maritime 2023 (Oct 2023). **Themes #3, Science and society.**
- Jalkanen, J-P., Johansson, L., Heikkilä, M., Majamäki, E. (2023) "Discharges to the sea from Baltic Sea shipping in 2022", Submission from Finland to HELCOM Maritime 2023 (Oct 2023). **Themes #3, Science and society.**
- Jalkanen, J-P., Johansson, L., Majamäki, E. (2023) "Underwater noise emissions from Baltic Sea shipping in 2022", Submission from Finland to HELCOM Maritime 2023 (Oct 2023). **Themes #3, Science and society.**
- Kangasniemi, O., Simonen, P., Moldanová, J., Timonen, H., Barreira, L. M. F., Hellén, H., Jalkanen, J-P., Majamäki, E., D'Anna, B., Lanzafame, G., Temime-Roussel, B., Mellqvist, J., Keskinen, J., Dal Maso, M. (2023) Volatility of a Ship Emission in the Baltic Sea Using Modelling and Measurements in Real-World Conditions, *Atmosphere*, **14**, 1175. <https://doi.org/10.3390/atmos14071175>. **Themes #3, Science and society.**
- Karl, M., Ramacher, M. O. P., Oppo, S., Lanzi, L., Majamäki, E., Jalkanen, J-P., Lanzafame, G. M., Temime-Roussel, B., Le Berre, L., D'Anna, B. (2023) Measurement and modeling of ship-related ultrafine particles and secondary organic aerosols in a Mediterranean port city, *Toxics*, **11**, 771. <https://doi.org/10.3390/toxics11090771>. **Themes #3, Science and society.**
- Manshausen, P., Watson-Parris, D., Christensen, M. W., Jalkanen, J-P., Stier Ph. (2023) Rapid saturation of cloud water adjustments to shipping emissions, *Atmos. Chem. Phys.*, **23**, 12545–12555, <https://doi.org/10.5194/acp-23-12545-2023>. **Themes #3, Science and society.**
- Paul, K.M., van Helmond, N.A.G.M., Slomp, C.P., Jokinen, S.A., Virtasalo, J.J., Filipsson, H.L., Jilbert, T. (2023) Sedimentary molybdenum and uranium: improving proxies for deoxygenation in coastal depositional environments. *Chemical Geology* **615**, 121203. **Theme #5.**
- Roth, F., Broman, E., Sun, X.L., Bonaglia, S., Nascimento, F., Prytherch, J., Bruechert, V., Zara, M. L., Brunberg, M., Geibel, M.C., Humborg, C., Norkko, A. (2023) Methane emissions offset atmospheric carbon dioxide uptake in coastal macroalgae, mixed vegetation and sediment ecosystems. *Nature Communications*, **14**. **Theme #1**
- Russo, M., Carvalho, D., Jalkanen J-P., Monteiro, A., (2023) Future impact of shipping emissions on air quality in Europe under climate change, *Atmosphere*, **14** (7), 1126. <https://doi.org/10.3390/atmos14071126>. **Themes #3, Science and society.**
- Solonen, A., Maraia, R., Springer, S., Haario, H., Laine, M., Rätty, O., Jalkanen, J-P., Antola, M., (2023) Hierarchical Bayesian propulsion power models for marine vessels, *Ocean*

Engineering, Volume 285, Part 1, 115226,

<https://doi.org/10.1016/j.oceaneng.2023.115226>. **Themes #3, Science and society.**

- Virtasalo, J.J., Österholm, P., Asmala, E. (2023) Estuarine flocculation dynamics of organic carbon and metals from boreal acid sulphate soils. *Biogeosciences* 20, 2883–2901. **Theme #5.**
- Ytreberg, E., Lunde Hermansson, A., Hassellöv, I-M., Jalkanen, J-P. (2023) Cumulative environmental risk assessment of metals and polycyclic aromatic hydrocarbons from ship activities in ports. *Marine Pollution Bulletin*, 189, 114805.
<https://doi.org/10.1016/j.marpolbul.2023.114805>. **Themes #3, Science and society.**

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2023? If yes, who? How did you engage?

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PART 2 - Planned activities for 2024 and 2025

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

- FMI is taking part in an onboard measurement campaign of GREEN RAY to determine methane slip from LNG vessel in spring 2024 (organized by Technical Research Centre of Finland VTT). **Themes #1, Science and society.**
- At FMI, there will be various modeling studies of air emissions, discharges, and underwater noise in 2024-2025. **Themes #3, Science and society**
- SYKE will continue the tests with a low-cost pH sensor throughout spring in FerryBox (H2020/NAUTILOS). **Theme #1**
- SYKE will report the developments in improving metrology of pH measurements in the SapHTies (EMPIR/H2020/EURAMET) project. **Theme #1.**

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

- Jukka-Pekka Jalkanen from FMI will (mainly **themes #3 and Science and society**)
 - Will be part of the organizing team in UH and FMI of the conference “Air-Quality – from science to applications 2024” in Helsinki, Finland, May 2024.
 - Will be co-convenor in one EGU2024 session.
 - Will participate in IMO PPR11 and IMO MEPC81 meetings in London, UK
- GTK will be the main organizer of the FINMARI Researcher Day 7.3. 2024 in Espoo, Finland. **All themes.**
- The 12th FerryBox Workshop will be organized in October 2024 in Helsinki, Finland.

Themes #1-#5.

3. Funded national and international projects/activities underway.

- Jukka-Pekka Jalkanen from FMI is the coordinator of H2020/EMERGE (Evaluating, control and Mitigation of the EnviRonmental impacts of shipping Emissions). **Themes #3, Science and Society.**
- Jukka-Pekka Jalkanen is the FMI PI of the Horizon Europe/GREEN RAY project aiming to assess and mitigate methane slip from shipping. **Themes #3, Science and Society.**
- Jukka-Pekka Jalkanen is the FMI PI of CAMS2-61 (Global and European emission inventories/ Copernicus Atmosphere Monitoring Service). **Themes #3, Science and Society.**
- Jukka-Pekka Jalkanen is the FMI PI ShipNOEm project (national funding) on NOx emissions from shipping. **Themes #3, Science and Society.**
- Jukka Seppälä from SYKE is the Finnish PI for the ongoing projects EU Horizon JERICO-S3 (Joint European Research Infrastructure of Coastal Observatories- Sciences, Service, Sustainability) and MINKE (Metrology for integrated marine management and knowledge transfer network). **All themes.**
- Kristian Spilling from SYKE coordinates project “The Impacts of Phytoplankton Community Composition and Particle Transport Pathways on the Biological Carbon Pump in Coastal Seas Under the Changing Climate – PHYTOTRANS” funded by Academy of Finland. **Themes #1, #5.**
- Joonas Virtasalo from GTK is the PI of an Academy of Finland Project called FERMAID - Ferromanganese Concretion-Archives of Ecosystem Variability, Climate Forcing and Anthropogenic Impact on the Baltic Sea. **Theme #5.**
- Joonas Virtasalo from GTK is the PI of an Academy of Finland Project called GEOMEASURE - Foundations for green offshore energy production in Finland: from marine investigations to the numerical estimation of undrained shear strength of the seabed deposit layers under cycling loading. **Theme #5.**
- Joonas Virtasalo from GTK is the PI of a Foundation for Research of Natural Resources in Finland Project: FeCoVERY - Recovery and sustainable use of Baltic Sea ferromanganese concretions as a resource of hi-tech metals. **Theme #5.**

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

- FMI is preparing applications at least to following funding instruments (mainly **themes #3, Science and society**):
 - Strategic Research Council, Water call (National funding).
 - Nordforsk Arctic call (Nordic Council of Ministers)
 - Business Finland (national funding) – underwater noise

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

- FMI is engaged or cooperating in the following organisations:
 - Planned cooperation with WWF Canada. **Themes #3, Science and Society.**
 - Extending cooperation with European Maritime Safety Agency EMSA, MoU signed. **Themes #3, Science and Society.**
 - Cooperation with the UK project Atmospheric Composition and Radiative forcing changes due to UN International Ship Emissions regulations ACRUISE. **Themes #3, Science and Society.**
 - Cooperation with Portuguese national shipping project. **Themes #3, Science and Society.**
 - Cooperation with Irish national project on alternative fuels for shipping. **Themes #3, Science and Society.**
 - Cooperation with Statistics Finland. **Themes #3, Science and Society.**

Comments

- The research related to shipping at FMI deals with environmental topics of the IMO MEPC (International Maritime Organization/Marine Environment Protection Committee), whether these relate to air emissions, discharges, or underwater noise. This facilitates wide cooperation in a range of topics.