MSc MODULE

CREDITS

Metal Contaminants – Metals in the Ocean

INTERDISCIPLINARY COURSE ON HEAVY METAL CONTAMINANTS IN THE MARINE ENVIRONMENT.

LEARN ABOUT

- Biogeochemical cycling of metals.
- Environment management strategies, and policy.
- Effects of climate change on heavy metals.
- Effects of both current and future ocean activities, interventions, and solutions.
- Analytical techniques.
- Risk assessment, management strategies, and policy.

DELIVERY:

a blend of hybrid & online lectures and hybrid applied learning exercises by international experts.

DATES: 14 October- 16 December, 2025.

Registration

CAU-Students via OpenOlat: bioc385-01a Metal Contaminants - Metals in the Ocean

SeaEU

Kiel University
Christian-Albrechts-Universität zu Kiel

GEOMAR

SEA-EU Marine Module description

Module offers for the SEA-EU 'Virtual Marine Open Elective Modules'

General Information

Module/Course Name	**Metal Contaminants – Metals in the Ocean**	
Module/Course Code	bioc385-01a	
Field of Education	Generic programmes and qualifications	☐
	Education	☐
	Arts and humanities	☐
	Social sciences, journalism and information	☐
	Business, administration and law	☐
	Natural sciences, mathematics and statistics	☒
	Information and Communication Technologies	☐
	Engineering, manufacturing and construction	☐
	Agriculture, forestry, fisheries and veterinary	☐
	Health and welfare	☐
	Services	☐
Study programme	Master of Science in Biological Oceanography	
Number of ECTS and total student workload	5 ECTS / 150 hours	
Contact hours and Independent study hours	Ca. 35 contact hours + 125 hours independent study	
Typology of contact hours	Lecture, Discussion and Exercise (ca. 25 hours in class), 10 hours for recorded lectures, 115 hours self-study, reading, preparation, online self-tests, and written and oral assignment preparation	
Academic Year	2025	
Semester / Specific period	Winter semester (i.e. September to January for SEA-EU)	
Teaching Language	English	
Delivery mode	This module takes place in a blended format, including self-study online lectures and on-site (hybrid) exercises. While	

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	one 1h lecture, followed by 1h exercise on the same topic, will take place on-site at GEOMAR and being made available for off-site students via WEBEX (i.e. hybrid), a second lecture will be provided as video recording, which can be viewed in the self-study phase. Video recorded lectures are produced solely for this module. Online discussion with lecturers is strongly encouraged. All lectures will be followed by ungraded knowledge tests. Exercises are aimed to deepen the theoretical knowledge and combine with practical application. Hybrid offer for international participation via Webex.
Responsible Lecturer	Name: Prof. Sylvia Sander E-Mail: ssander@geomar.de
Other lecturers	Invited international guest lecturers, including from other SEA-EU universities, providing best expertise on the topics. The list of confirmed lecturers can be found in the module plan provided.
Learning outcomes	This course provides a comprehensive insight to the topic of marine metal contaminants, encompassing their chemistry, environmental toxicology, risk assessments, management, and analytical skills. By the end of the course, students will have developed an interdisciplinary understanding and practical expertise on metals in the ocean and the skills to assess and evaluate potential impacts of metal contaminants in marine environments.
Course contents	Students will study the transport, fate, and speciation of metals, alongside bioavailability, bioaccumulation, and detoxification mechanisms. The curriculum emphasises evaluating biotic responses to metal exposure, utilising biomarkers, and conducting risk assessments through environmental toxicology principles. A key focus is on the impact of current and future ocean activities, such as deep- sea mining and ocean alkalinity enhancement, on metal contamination. Students will analyse these activities' environmental implications and explore potential solutions. The course also covers the scientific, technological, societal, and economic aspects of ocean interventions, integrating natural sciences with economics, biotechnology, ethics, policy, and ocean governance. Case studies will provide practical insights into contemporary marine ecotoxicology applications.

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	The blended course format will consist of on-site/hybrid, as well as self-study online lectures, on-site/hybrid Q&A sessions and applied learning exercises. While the hybrid/online lectures will be accompanied by online self-tests, the exercises will deepen the theoretical knowledge by examples of practical application. Students will read and discuss selected papers, and engage in group discussions. Each student will also identify a topic of interest and produce an assay, as well as present it to the group. The topic of the presentation may be any area of metal contaminants, a case study, or a question (e.g., impact of climate change, efficacy of ocean solutions/interventions) with an explicit link to marine metal contaminants.
Prerequisites and/or recommended academic background	None.
Assessment	Internal assessment (100%), based on written assay and individual oral presentation. Prerequisite to deliver the oral presentation is an active participation during the seminars.
Main bibliography	Relevant literature will be distributed over the course of the module.

Organisational Information

Maximum number of SEA-EU participants
15
Learning Management System
OpenOlat
Course schedule (date and time)
In-person/hybrid lectures & exercises on Tuesdays 15:30 - 17:30 h (CET), video recorded lectures provided each Friday, between 14th October and 16th December 2025.
Application deadline
28th September 2025

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bioc385-01a METAL CONTAMINANTS – METALS IN THE OCEAN WS2025/26
Module Structure and dates – updated 2.9.25

Format/date	Topic	Primary Lecturer/s *(affiliations)*
14.10. 2025 in-person for Kiel students, others hybrid @16:30 CET	**Introduction** o Course organizers, lectuers and participants o SeaEU o Course structure, expectations, workload and grading	**Prof. Sylvia Sander** *(GEOMAR & CAU)* **Leah Schroedter** *(SEA-EU)*
17.10.2025 Lecture 1 online	**Introduction of metals in the Ocean** o Importance of metals o Natural and anthropogenic sources and sinks Distribution	**Prof. Sylvia Sander** *(GEOMAR & CAU)*
21.10. 2025 Lecture 2 and Exercise, hybrid	**Introduction to sample collection and analytical methods of metal contaminants in the marine environment** o Trace metal clean working procedures o Discrete surface water samplers (SLM sampler, Niskins) o Discrete deep-water samplers (CTD, ROV (IGT, KIPS, Major) Bottom Water Samplers) o In-situ samplers/DGT o Trace metal clean analysis / sample handling o ICP-MS, Voltammetry, DMA, etc.	**Prof. Sylvia Sander** *(GEOMAR & CAU)*
24.10. 2025 Lecture 3, online	**Trace Metals as micro nutrients** o metabolic roles o bioavailability, limitation/excess o analytical techniques/methods to asses bioavailability, bioaccumulation o biotic and ecosystem responses of metal contaminants in the marine environment o links to climate	**Dr. Christel Hassler** *(EPFL, Switzerland)*
28.10.2025 Lecture 4 and Exercise, hybrid	**Analytical error and uncertainty estimation**	**Prof. Ivo Leito** *(Univ Tartu, Estonia)*
31.10. 2025 Lecture 5, online	**Natural iron fertilization: Heard Island volcanic iron in the Southern Ocean**	**Dr. Thomas Holmes** (*Institute of Marine and Antarctic Studies, Australia*)
31.10. 2025 Lecture 6 and Exercise, hybrid	**Introduction to current natural metal contaminant issues** o floods o dust o volcanoes o groundwater	**Prof. Sylvia Sander** *(GEOMAR & CAU)*
31.10.2024 Lecture 7, online	**Introduction to current anthropogenic metal contaminant issues and solutions** o Use of biocides in ships paint o Mine tailing issues o Deep-sea mining	**Prof. Sylvia Sander** *(GEOMAR & CAU)*
4.11. 2025 Lecture 8 and Exercise, hybrid	**Ecotoxicology and deep-sea mining**	**Dr. Nélia C. Mestre** *(Universidade do Algarve, Faro, Portugal)*
7.11.2025 Lecture 9, online	**Trophic Transfer and Biogeochemistry of Mercury: Implications for Seafood Safety**	**Dr. Michael Bank** (*Norwegian Institute of Marine Research, Norway*)
11.11.2025 Lecture 10 and Exercise, hybrid	**Environmental risk assessment of anthropogenic metal contaminant issues** **Introduction to** sediment quality guidelines, enrichment indices vs. toxicity indices, pseudo total heavy metal concentrations as indicators for toxicity risks in Sediments vs. labile fractions concentrations **Practical exercises**: Development of a monitoring plan for the diagnosis of the heavy metal contamination, development of a communication plan and presentation of small-group results.	**Assoc. Prof. Daniel Rosado** *(University of Sevilla, Spain)*
14.11.2025 Lecture 11, online	**Effect of ocean solutions on metals distribution** o Ocean alkalinity enhancement **Case study:** Volcanic eruptions as a source of fertilizing and harmful metals – possible insights for ocean alkalinity enhancement research	**Assoc. Prof Linn Hoffmann** (*University of Otago, New Zealand*)
18.11. 2025 Lecture 12 and Exercise, hybrid	**Marine Geochemical Modelling** o Basics o the carbonate system	**Dr. Laura Haffert** (*GEOMAR)*

	○ inorganic speciation of metals **Hands on geochemical modelling using MARCHEMSPEC**	
21.11.2024 Lecture 13, online	**Effect of climate change on contaminants and pollutants in the ocean with specific focus on heavy metals**	**Dr. Dario Omanovic** *(IRB, Zagreb, Croatia)*
25.11. 2025 Lecture 14 and Exercise, hybrid	**Emerging topics on metals speciation and environment applications in plastics and drugs decomposition** (such as polyoxometalates)	**Prof Manuel Aureliano (***University of Algarve, Portugal)*
28.11.2024 Lecture 15, online	**Legal aspects of using the High Seas (area beyond national jurisdiction)** ○ Legal frameworks of the ocean ○ The International Seabed Authority	**Prof. Nele Matz-Lück (tbc)** (*CAU, Germany*)
2.12.2024 Lecture 16 and Exercise, hybrid	**Ways to take action for global change: how can we influence policy**	**Dr. Praneep Singh** *(RIFS), tbc*
5.12.2024 Lecture 17, online	**UN Environment Program: Minamata convention and how science informs global decisions**	**Dr. Gamini Manuweera** *(Consultant, prev. UNEP, USA)*
9.12.2024 Lecture 18 and Exercise, hybrid	**Social Science Aspects and Community Science Activities**	**Dr. Sarah Schönbauer** *(Technische Universität München)*
12.12.2024 Hybrid (15:30 CET)	**Preparation meeting for oral presentation to cover open questions**	**Prof. Sylvia Sander** *(GEOMAR & CAU)*,
16.12.24 Exam	**Oral presentations** by students of selected topics (graded)	**Prof. Sylvia Sander** *(GEOMAR & CAU)*