2019

Module Handbook

M.Sc. Polar and Marine Sciences

- POMOR

Hamburg University /

Saint Petersburg State University

May 2020

Content

Partners

POMOR is a joint master program of the Hamburg University and the Saint Petersburg State University in cooperation with Russian and German universities and research institutions:

Universities:

Saint Petersburg State University, Russia

Hamburg University, Germany

Bremen University, Germany

Kiel University, Germany

Rostock University, Germany

Potsdam University, Germany

Hamburg University of Technology, Germany

Research institutions:

Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Germany

Arctic and Antarctic Research Institute, Russia

GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany

Leibniz Institute for Baltic Sea Research Warnemuende, Germany

Koeppen Laboratory at the Saint Petersburg State University (Laboratory "Paleoceanography and Geomorphology Research of Polar Countries and the World Ocean")

Otto Schmidt Laboratory for Polar and Marine Research at the Arctic and Antarctic Research Institute

Academician I. S. GRAMBERG All-Russia Scientific Research Institute for Geology and Mineral Resources of the Ocean

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Structure scheme of the M.Sc. POMOR

Module No.	Semester, module type and teaching and learning methods	Work load	SWH	CP
Compulsive C. Elective El, Lecture L, Practical training P, Seminar S, Excursion E.				
1st semester (winter semester = WS), St. Petersburg State University, Russia Russian and German* lecturers				
1.	Ocean basins, sediments and climate change; C; L, P, S, E	270	6	9
2.	High seas and coastal waters oceanography; C; L, P, S, E	270	6	9
3.	Polar and marine ecosystem: structure, functioning and vulnerability: C; L, P, S, E	270	6	9
Core	Core Part 1: C; L, P, S, E	60	2	2/6
	Sum	**870**	**20**	**29**
2 nd semester (summer semester = SS), St. Petersburg State University, Russian and German lecturers				
4.	Natural resources: C; L, P, S, E	270	6	9
5.	Processes in the coastal zone and environmental management; C; L, P, S, E	270	6	9
6.	Periglacial environment: C; L, S	270	6	9
Core	Core Part 2: C; L, S, P incl. field practice**	120	2	4/6
	Sum	**930**	**20**	**31**
3 d semester (winter semester = WS), Germany)				
	Semester abroad at one of the partner universities in Germany: Seminar, Study Project, Additionals - Hamburg University, M.Sc. Integrated Climate System Sciences (ICSS); - Bremen University, M.Sc. Marine Biology; M.Sc. Marine Geosciences -Christian Albrecht University of Kiel, M.Sc. Marine Geosciences; - Potsdam University, M.Sc. Geosciences/ Geology	900	20	30
	Sum	**900**	**20**	**30**
4 th semester (summer semester = SS), Russia or Germany				
	Master thesis in polar and marine sciences ** with Defence: C	900	20	30
	Sum	**900**	**20**	**30**
	Total for the M.Sc. Polar and Marine Sciences	**3600**	**80**	**120**

*Lecturers from:

Hamburg University, Germany
Bremen University, Germany
Kiel University, Germany
Rostock University, Germany
Potsdam University, Germany
Hamburg University of Technology, Germany
Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Germany
Helmholtz Centre for Ocean Research Kiel, Germany
Leibniz Institute for Baltic Sea Research Warnemuende, Germany

**Field practice and master thesis are performed in cooperation with:

Saint Petersburg State University, Russia
Hamburg University, Germany
Bremen University, Germany
Kiel University, Germany
Rostock University, Germany

Potsdam University, Germany
Hamburg University of Technology, Germany
Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Germany
Arctic and Antarctic Research Institute, Russia
Helmholtz Centre for Ocean Research Kiel, Germany
Leibniz Institute for Baltic Sea Research Warnemuende, Germany
Koeppen Laboratory at the Saint Petersburg State University (Laboratory “Paleoceanography and Geomorphology Research of Polar Countries and the World Ocean”)
Otto Schmidt Laboratory for Polar and Marine Research at the Arctic and Antarctic Research Institute

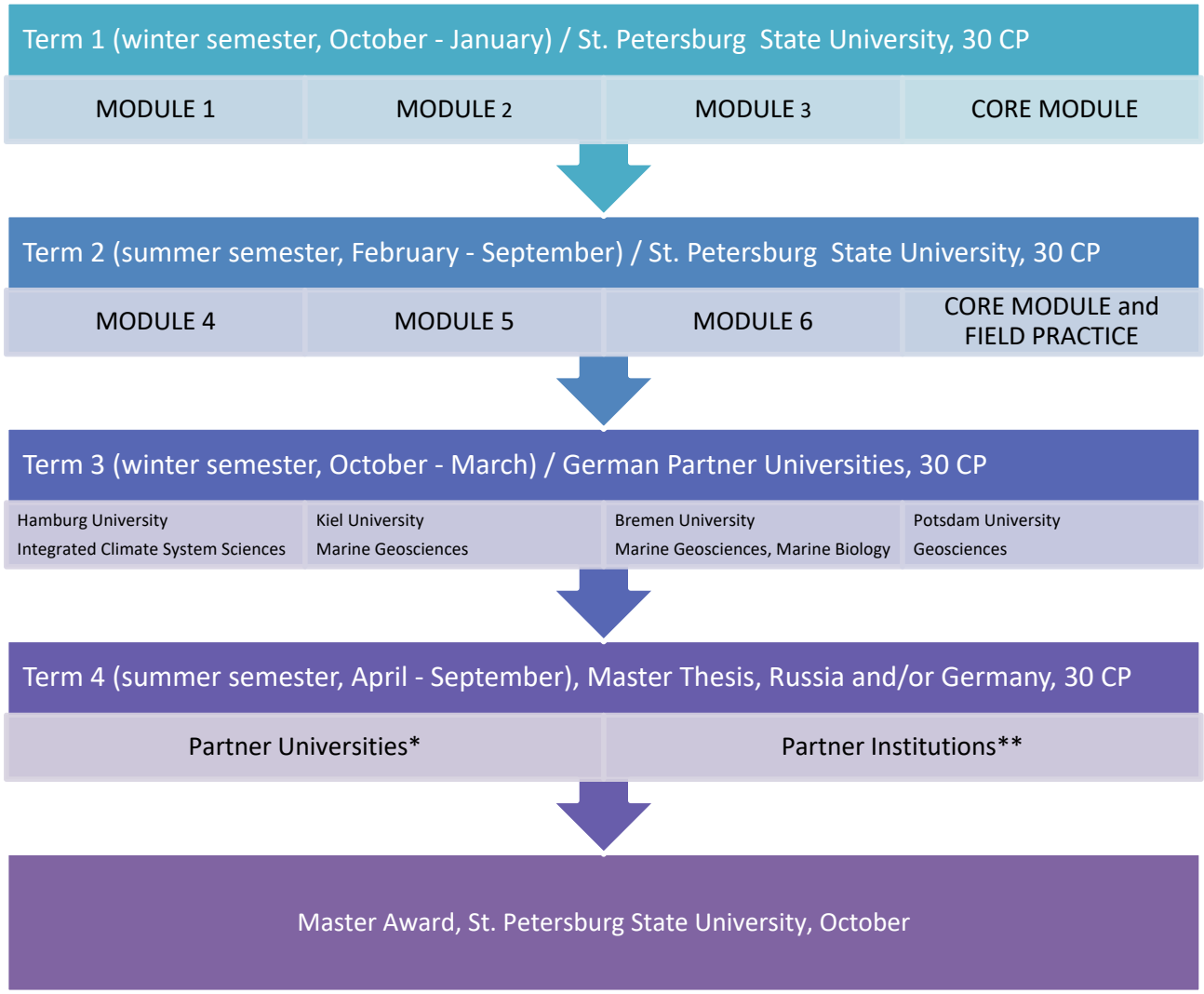

Figure 1: Structure of the M.Sc. Program POMOR

*Partner universities:
Saint Petersburg State University, Russia
Hamburg University, Germany
Bremen University, Germany
Kiel University, Germany
Rostock University, Germany
Potsdam University, Germany
Hamburg University of Technology, Germany
** Partner institutions:
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Semester 1 – Winter Semester

Module 1 Ocean Basins, Sediments and Climate Change

Module title	**Module 1** **Ocean Basins, Sediments and Climate Change**
Abbreviation	M1
Module goals / Learning outcomes	After completing this module, the students • have a knowledge in polar marine sedimentation processes related to climate change • have a knowledge on how environmental variability is reflected in marine paleoclimate archives • are able to interpret data obtained by state-of-the-art methods of marine sediment investigation (sampling, facies analysis, climate proxies, age determination) • are able to apply modern marine technologies • have basic skills in geochemical and geochronological lab investigation of marine sediments
Content	The module concentrates on two fields of marine research: • marine geology of the seafloor and continental margins with a focus on plate tectonics of oceanic crust and morphodynamics and sedimentary budgets of deep-sea deposits • Earth's climate and its variability during geologic history with a special focus on polar regions. Advanced topics of research on climate dynamics are presented, covering climate reconstructions based on geological records and the application of lab techniques to survey recent and ancient ocean environment The module program is completed by a course on deep-sea technologies (development and use of research devices adapted for deep-sea conditions). In all courses, emphasis will be put on the application of state-of-the-art methods and on the discussion of case studies.
Educational concept	5 courses including lectures with seminars, practical training and excursions: 1.1 Marine sediments and polar sedimentation processes; L, P, E [R. Stein, R. Spielhagen, R. Rendle-Bühring] CP 3 / 36 h 1.2 Methods in marine geosciences; L, P, S, E [G. Fedorov, V. Kuznetsov] CP 2 / 28 h 1.3 Methods of seafloor mapping; L, P [G. Leitchenkov, A. Piskarev-Vasiliev] CP 1 / 14 h 1.4 Ocean basins: morphology, tectonic structure and dynamics; L, S [A. Krylov] CP 2 / 28 h 1.5 Marine geotechnology; L, E [G. Leitchenkov, A. Piskarev-Vasiliev] CP 1 / 14h
Language	English
Term, duration, frequency of offer	Term 1, winter semester Duration: one semester Frequency of offer: every second year in winter semester
Workload	Campus study: 120 h

Module title	**Module 1** **Ocean Basins, Sediments and Climate Change**	
Examinations / Types of examinations	Self-Study	120 h
	Exam preparation	30 h
	Type:	1 written module exam
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory
	Language:	English
	Duration / size:	Max. 90 min.
	Grade:	Average grade of the courses
Credit points (ECTS)	9.0	
Formal requirements for participation	None	
Recommended pre-requisites	None	
Module type	Compulsory	
Module Supervisor	T. Bickert, A. Krylov, V. Kuznetsov, R. Stein	
Lecturers	G. Fedorov, A. Krylov, V. Kuznetsov, G. Leitchenkov, R. Spielhagen, A. Piskarev-Vasiliev, R. Rendle-Bühring, R. Stein	
Literature	Alexanderson H., Backman J., Cronin T.M., Funder S., Ingólfsson Ó., Jakobsson M., Landvik J.Y., Löwemark L., Mangerud J., März C., Möller P., O'Regan M., Spielhagen R.F., 2014. An Arctic perspective on dating Mid-Late Pleistocene environmental history: Quaternary Science Reviews, Vol. 92, p. 9-31 Anderson John. B, 1999. Antarctic Marine Geology. Cambridge University Press, Cambridge, 292 p. Elias, S.A. (Ed.), 2013. The Encyclopedia of Quaternary Science, second ed., , Elsevier, Amsterdam, Vol. 1-4. Harff, J., Meschede, M., Petersen, S., Thiede, J. (Eds.), 2016. Encyclopedia of Marine Geosciences. Springer Science, 961 p. Hillaire-Marcel, C., de Vernal, A., 2007. Proxies in Late Cenozoic Paleoceanography: Developments in Marine Geology, Vol. 1, 843 p. Huneke H., Mulder, T., 2011. Deep-sea sediments: Developments in Sedimentology. Vol. 63. Elsevier, Amsterdam. Hardbound, 849 pp. Kuenen H., 2008. Marine Geology. Baltzell Press. 596 p. Poulos H. G., 1988. Marine Geotechnics. Routledge. 473 p. Randolph M., Gourvenec S., 2011. Offshore Geotechnical Engineering. Taylor & Francis. 550 p.	

Module title	Module 1 Ocean Basins, Sediments and Climate Change
	Smith M., Paron P., Griffiths J., 2011. Geomorphological Mapping: Methods and Applications. Elsevier science. 610 p. Stein, R., 2008. Arctic Ocean Sediments: Processes, Proxies, and Palaeoenvironment. Developments in Marine Geology, Vol. 2, Elsevier, Amsterdam, 587 pp. Wagner, G. A., 1998. Age Determination of young rocks and artifacts. Springer, 466 pp. Specific literature will be announced during the courses

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Module 2 High Seas and Coastal Waters Oceanography

Module title	**Module 2** **High Seas and Coastal Waters Oceanography**	
Abbreviation	M2	
Module goals / Learning outcomes	After completing this module, the student: • has to get knowledge and understanding of the basic principia of structure of the open ocean and coastal waters; • can achieve advanced knowledge of the properties of seawater, sea ice, currents in the sea, waves, tidal phenomena and acoustics of the sea; • will be able self-sufficiently to carry out measurements, analysis, and interpretation and processing of oceanographical data.	
Content	The courses cover basic aspects of oceanography in general and specified for the seas in polar regions: • physical oceanography (properties of seawater, sea ice, currents, waves and tides, equations of motion and continuity of volume, geostrophic motion, wind-driven current system over the ocean, Ekman transport, dynamics of wind-driven coastal flow) • ocean-atmosphere interaction • introduction to the methods of oceanographic research and data management	
Educational concept	7 courses include lectures, seminars and practical exercises: 2.1 Oceanographic measurements and data analysis. L, S [**NN**] CP 0.5 / 10 h 2.2 Atmosphere - Sea Ice - Ocean Interaction in Polar Regions; L, S, P [B. Ivanov, A. Rinke, D. Handorf] CP 2 / 28 h 2.3 Ocean currents; L, S [V. Ionov] CP 1.5 / 14 h 2.4 Ocean waves; L, S, P [L. Lopatukhin] CP 1.5 / 14 h 2.5 Basics of physical oceanography; L, S, P [A. Rubchenia] CP 1 / 14 h 2.6 Tides in the ocean; L, S [**NN**] CP 0.5 / 12 h 2.7 Coastal ocean dynamics; L, S, P [H. Burchard, O. Savchuk] CP 2 / 28 h	
Language	English	
Term, duration, frequency of offer	Term 1, winter semester Duration: one semester Frequency of offer: every second year in winter semester	
Workload	Campus study	120 h
	Self-Study	120 h
	Exam preparation	30 h
Examinations / Types of examinations	Type:	1 written module exam
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory

Module title	**Module 2** **High Seas and Coastal Waters Oceanography**	
	Language:	English
	Duration / size:	90 min.
	Grade:	Average grade of the courses
Credit points (ECTS)	9.0	
Formal requirements for participation	None	
Recommended pre-re-quisites	Basics in mathematics, physics and geography	
Module type	Compulsory	
Module Supervisor	V. Ionov, **NN GER**	
Lecturers	H. Burchard, D. Handorf, V. Ionov, B. Ivanov, L. Lopatukhin, A. Rinke, A. Rubchenia, O. Savchuk	
Literature	Brown, E. and Colling, A., 2001: Ocean Circulation. Butterworth Heinemann in association with the Open University, Oxford, 286 pp. Bowden, K.F., 1983: Physical Oceanography of Coastal Waters, Ellis Horwood Ltd., Chichester England, 302 pp. Volkov, Vladimir V., Ola M& Johannessen, Victor E. Borodachev, Gennadiy N. Voinov, Lasse Y. Petersson, Leonid P. Bobylev and Alexei V. Kouraev., 2002: Polar Seas Oceanography. An Integrated study of the Kara Sea. Springer, UK, 450 pp. Emery, William J., Richard E. Thomson 2004: Data Analysis Methods in Physical Oceanography. Second and Revised Edition. Elsevier, 638 pp. Stewart, Robert H., 2005: Introduction to physical oceanography. http://oceanworld.tamu.edu/resources/ocng_textbook/contents.html Tomczak, Matthias & J Stuart Godfrey, 2003: Regional Oceanography. http://www.es.flinders.edu.au/~mattom/regoc/pdfversion.html Pipkin, B. W., Gorsline, D.S., Casey, R.E. and Hammond, D. E., 1977: Laboratory Exercises in Oceanography. Freeman, San Francisco. 255 pp. http://www.es.flinders.edu.au/~mattom/regoc/pdfversion.html Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Module 3 Polar and Marine Ecosystem: Structure, Functioning and Vulnerability

Module title	**Module 3** **Polar and Marine Ecosystem: Structure, Functioning and Vulnerability**
Abbreviation	M3
Module goals / Learning outcomes	After completing this module, the students • understand species evolution, patterns of biodiversity and its role in a changing climate and within biogeochemical cycles • have gained advanced knowledge of structure, functioning and vulnerability of polar and marine ecosystems • are knowledgeable of modern methods of ecological research, regulation, risk assessment and how mathematical models of the ecosystem and to study ecological processes by mathematical modelling are constructed • have gained knowledge about interaction of the biosphere with modern state of oil and gas reserves and pollution in the Arctic Ocean, prospective areas for development • have knowledge and skills in field sampling strategy, working at special scientific equipment for analytical procedures in biology and geoecology
Content	Different aspects of polar ecosystem functioning and man-induced effects on them are considered in this module: • specific features of polar and marine ecosystems, the role of sea-ice in polar ecosystems • terrestrial ecosystems in polar regions • marine ecosystems: sympagic, pelagic and benthic communities in polar seas from shelf to the open ocean and from microbial processes to marine mammals • introduction to multivariate statistics in community analysis and ecosystem modelling • examples of ecosystem services from selected ocean regions e.g. marine natural resources, ecological effects of using living resources (fisheries, whaling and sealing), sustainability and stability of ecosystems for biogeochemical processes, ecosystem function for society (in correspondence of module 4) • anthropogenic impacts on polar ecosystems, mineral resources exploration and its effect on climate change • methods of ecological standardization and ecological regulation. • microbial diversity in native and anthropogenically affected polar ecosystems • species and functional groups diversity from microorganisms, plankton, benthos and higher trophic levels in different terrestrial and marine polar environments • effects on biota of anthropogenic influence in polar ecosystems as indicators of ongoing change • bio-ethics and natural wildlife conservation in the framework of ecological regulation according to requirements of local states and international rules

Module title	**Module 3** **Polar and Marine Ecosystem: Structure, Functioning and Vulnerability**	
Educational concept	7 courses include lectures with seminars and practical training: 3.1 Biodiversity in marine and polar ecosystems; L, S [U. Bathmann] CP 1 10h 3.2 Biological oceanography of pelagic ecosystems, principles, examples, future scenarios and modelling; L, S [U. Bathmann] CP 1 14h 3.3 Biology and ecology of the seafloor fauna (benthos) of coastal and polar oceans; L, E [D. Piepenburg] CP 2 24h 3.4 Introduction to the polar ecology and sea-ice ecology; L, S [B. von Bodungen] CP 0.5 12h 3.5 Geoecology of Polar Regions and impacts on ecosystems [I. Fedorova, E. Elsukova, A. Yurova, P. Strelkov] – 2 CP (26 h) 3.6 Biology and ecosystem modeling [E. Vlasov, M. Nadporozhskaya, O.Savchuk, P. Strelkov] - 1,5 CP (20 h) 3.7 Ecological regulation and utilisation of marine natural resources in Polar Regions [E. Abakumov, I. Arestova] – 1 CP (14 h) During the semester students elaborate a student project that focus on a research topic with a theoretical and a practical part. The results are presented in the class	
Language	English	
Term, duration, frequency of offer	Term 1, winter semester Duration: one semester Frequency of offer: every second year in winter semester	
Workload	Campus study	120 h
	Self-Study	120 h
	Exam preparation	30 h
Examinations / Types of examinations	Type:	Oral presentation of the student project
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory
	Language:	English
	Duration / size:	Max. 15 min. per one presentation
	Grade:	Content of presentation: 75% Presentation: 10 % Discussion: 15 %
Credit points (ECTS)	9.0	
Formal requirements for participation	None	

Module title	**Module 3** **Polar and Marine Ecosystem: Structure, Functioning and Vulnerability**
Recommended pre-requisites	None
Module type	Compulsory
Module Supervisor	U. Bathmann, I. Fedorova, D. Vlasov
Lecturers	E. Abakumov, I. Arestova, U. Bathmann, B. von Bodungen, E. Elsukova, I. Fedorova, M. Nadporozhskaya, D. Piepenburg, O. Savchuk, P. Strelkov, D. Vlasov, A. Yurova
Literature	Bargagli R., 2005. Antarctic Ecosystems: Environmental Contamination, Climate Change, and Human Impact. Ecological Studies, Vol.175, Springer, 395 pp. Bej, Asim K., Aislabie, Jackie, Atlas, Ronald M., 2009. Polar Microbiology: The Ecology, Biodiversity and Bioremediation Potential of Microorganisms in Extremely Cold Environments. CRC Press, 424 pp. Gerday, C., Glansdorff, N., 2007. Physiology and Biochemistry of Extremophiles. ASM Press, 472 pp. Ims, R., Fuglei, E. 2005. Trophic interaction cycles in tundra ecosystems and the impact of climate change. Bioscience 55(4), 311−322 pp. Kaiser, M. J., Attrill, M., Jennings, S., and Thomas, D. N., 2009. Marine ecology: processes, systems, and impacts. Oxford University Press, 557 pp. Lalli, C.M., Parsons T.R., 1993 Biological Oceanography: An introduction. Pergamon Press, Oxford, 301 pp. Nybakken, J. W., Bertness, M. D., 2004. Marine biology: an ecological approach. Benjamin/Cummings Pub Co., 579 pp. Thomas, D. N., Dieckmann, G. S., 2003. Sea ice: an introduction to its physics, biology and geology. Blackwell Science, Oxford, 402 pp. Vincent, Warwick F., Laybourn-Pa rry, J., 2008. Polar Lakes and Rivers: Limnology of Arctic and Antarctic Aquatic Ecosystem. Oxford University Press, 327 pp. Specific literature will be announced during the courses

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Core Module

Module title	Core Module
Abbreviation	CM
Module goals / Learning outcomes	After completing this module students: • have gained soft skills and personal competence for scientific work and career • can review literature, manage and process data and publicly present scientific information • are informed about the rules of good scientific practice • have improved their English language skills • have studied history of polar regions and polar sciences • have obtained research experience during their field practice • can formulate a research hypothesis • can manage scientific data • can apply geographic information systems
Content	The Core Module will be taught during the two first semesters (Part 1 in the first semester, Part 2 in the second semester). This module involves the following topics: • history of polar research and scientific approaches • soft skills and scientific presentation skills (data management, presentations, posters, publications, thesis) • introduction to GIS • safeguarding good scientific practice • a student project: intensive study of a research topic, project planning, field and/or laboratory studies with the following preparation of a report and the scientific presentation at the POMOR student conference • An intensive English course will be offered at the beginning of the first semester (daily, 1-30 September).
Educational concept	5 courses include lectures, seminars and practical exercises: CM.1 Soft skills; L, P, S [H. Kassens, R. Rendle-Bühring] h 20, CP 1 CM.2 History of polar research; L [V. Lukin, J. Thiede] h 10, CP 0.5 CM.3 Introduction into usage of online scientific information [I. Razumova] h 10, CP 0.5 CM.4 Introduction GIS, soft skills and rules of good scientific practice; L, S, P [W-Ch. Dullo, E. Panidi] h 30, CP 1 CM.5 Field practice implemented in a student project incl. presentation at the POMOR student conference; P, S [all module coordinators] h 90, CP 3
Language	English
Term, duration, frequency of offer	Term 1+2, winter+summer semester Duration: two semesters Frequency of offer: every second year in winter and in summer semester

Module title	**Core Module**	
Workload	Campus study	55 h
	Self-Study	85 h
	Exam preparation	40 h
Examinations / Types of examinations	Type:	1 oral presentation after the first semester, 1 written report and 1 presentation on the POMOR students conference after the second semester
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory
	Language:	English
	Duration / size:	Each max. 15 minutes
	Grade:	Average of the courses
Credit points (ECTS)	6.0	
Formal requirements for participation	None	
Recommended pre-requisites	None	
Module type	Compulsory	
Module Supervisor	N. Kaledin, H. Kassens	
Lecturers	W.-Ch. Dullo, H. Kassens, V. Lukin, E. Panidi, I. Razumova, R. Rendle-Bühring, J. Thiede	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Semester 2 – Summer Semester

Module 4 Natural Resources

Module title	Module 4 Natural Resources	
Abbreviation	M4	
Module goals / Learning outcomes	After completing this module, the students • have gained advanced knowledge of general aspects of non-living resources with special emphasis on soils, minerals, and hydrocarbons, living terrestrial and marine resources in the Arctic and their use • understand and be able to use methods for processing and interpreting geophysical data • demonstrate a fundamental understanding of economic risk assessment of exploration and production of resources in the Arctic • carry out independently: measurement, analysis, interpretation and data processing under condition of polar regions • have learned the decision making language based on scientific footing	
Content	The module covers exploration of mineral and living resources in polar regions and methods of their sustainable exploitation including: • general risk assessment, land and leasing theory • basic geophysical methods used by exploration with processing and interpretation of geophysical and geological data • methods of hydrocarbon exploration and exploitation • methods of mineral exploration and exploitation • peculiarities of natural polar land and marine environments • sustainable use of living and non-living resources	
Educational concept	The module includes lectures, seminars, practical exercises and excursions: 4.1 Economic and social geography of the Arctic; L, S [K. Klokov] CP 0.5 / 8 h 4.2 Living resources in the Arctic environment and their use; L, S [O. Galanina] CP 1.5 / 20 h in correspondence with module 3 4.3 Mineral resources; L, S [G. Cherkashov] CP 1 / 12 h 4.4 Hydrocarbon resources; L, P, S, E [W.-Ch. Dullo] CP 3.5 / 46 h 4.5 Processing and analysis of geophysical data; L, P, S [V. Troyan, A. Dehghani] CP 2.5 / 34 h	
Language	English	
Term, duration, frequency of offer	Term 2, summer semester Duration: one semester Frequency of offer: every second year in summer semester	
Workload	Campus study	120 h
	Self-Study	120 h
	Exam preparation	30 h
Examinations / Types	Type:	1 written module exam

Module title	**Module 4** **Natural Resources**	
of examinations		
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory
	Language:	English
	Duration / size:	Max. 90 min.
	Grade:	Average grade of the courses
Credit points (ECTS)	9.0	
Formal requirements for participation	None	
Recommended pre-requisites	Basics of geophysics, geology and ecology	
Module type	Compulsory	
Module Supervisor	W.-Ch. Dullo, V. Troyan	
Lecturers	G. Cherkashov, A. Dehghani, W.-Ch. Dullo, O. Galanina, K. Klokov, V. Troyan	
Literature	Harff J. et al. (eds.) 2016. Encyclopedia of Marine Geosciences, DOI 10.1007/978-94-007-6238-1, Springer Science+Business Media Dordrecht Sharma R. (ed.) 2017. Deep-Sea Mining. Resource Potential, Technical and Environmental Considerations. Springer International Publishing AG. P. 143-165. DOI 10.1007/978-3-319-52557-0_4 Petersen, S. et al. 2016. News from the seabed – Geological characteristics and resource potential of deep-sea mineral resources, Mar. Policy. http://dx.doi.org/10.1016/j.marpol.2016.03.012i Ponomarenko, A.V. Kashtan, B.M., Troyan, V.N. and Mulder, W.A., 2017. Surface-wave inversion for a P-velocity profile with a constant depthgradient of the squared slowness: Geophysical Prospecting, Volume 65, Issue 4, pp. 941–955 DOI: 10.1111/1365-2478.12450 Znak, P.E., Kashtan B.M. and Troyan ,V.N. , 2016. Guided Waves Leaking From High-Velocity Elastic Layer. 7th EAGE Saint Petersburg International Conference and Exhibition, Saint Petersburg. DOI 10.3997/2214-4609.201600113 Ponomarenko, A.V., Kashtan, B.M. , Troyan, V.N. and Mulder, W.A., 2015. Estimating a Continuous P-wave Velocity Profile with Constant Squared-slowness Gradient Models from Seismic Field Data. Proceedings of the Near Surface Geoscience 2015, 21st European Meeting of Environmental and Engineering Geophysics, Turin (Italy), 6-10	

Module title	Module 4 Natural Resources
	Sept., 2015. Molodtsov, D.M., Troyan, V.N., Bobrov, N.Y., Popov, D.A., 2015. Application of anisotropic joint total variation to inversion of seismic and magnetotelluric data. Geomodel 2015 - 17th Scientific-Practical Conference on Oil and Gas Geological Exploration and Development, pp. 226-230 V.V. Kazei, B.M. Kashtan, V.N. Troyan and W.A. Mulder FWI spectral sensitivity analysis in the presence of a free surface // SEG International Exposition and 85th Annual Meeting — USA, — 2015. Nasyrov, D., Kiyashchenko, D., Kiselev, Yu. , Kashtan, B., Troyan, V., 2015. Velocity analysis with vertical seismic profile data using migration of surface-related multiples. Geophysics, Vol. 80, № 6, pp. U73-U86. https://doi.org/10.1190/geo2015-0107.1 Bret-Rouzaut, N., Favennec, J.-P., 2011. Oil and Gas Exploration and Production: Reserves, Costs, Contracts. Editions Technip. Flavio Poletto, Francesco Flügel, E., 2005. Microfacies of Limestones. Springer, 975 pp. Sheriff, R. E., 2010. Encyclopaedic dictionary of applied geo-physics, 4th edition. Society of Exploration. Geophysics. Tulsa. Troyan, V., 2009. Inversion of geophysical problems, St. Pe-tersburg, 184 pp. Troyan, V., Kiselev, Yu., 2010. Statistical methods of geophysical data processing, World Scientific, New Jersey, 436pp. Atlas of marine and coastal biological diversity of the Russian Arctic, 2011. Moscow, WWF Russia, 64 pp. Walker, D.A., Raynolds, M.K., Daniëls, F.J.A., Einarsson, E., Elvebakk, A., Gould, W.A., Katenin, A.E., Kholod, S.S., Markon, C.J., Melnikov, E.S., N.G., M., Talbot, S.S., Yurtsev, B.A., CAVM Team 2005. The Circumpolar Arctic Vegetation Map. *Journal of Vegetation Science*. 16(3):267-282. PDF. doi:10.1658/1100-9233(2005)016[0267:TCAVM]2.0.CO;2. Oiffer L., Siciliano S. D. 2009. Methyl mercury production and loss in Arctic soil. Journal: Science of The Total Environment - SCI TOTAL ENVIR, vol. 407, no. 5, pp. 1691-1700. http://www.sciencedirect.com/science/article/pii/S004896970801053X# Sydeman W. J., Thompson S. A., Kitaysky A. 2012. Seabirds and climate change: roadmap for the future. Marine Ecology Progress Series. Vol. 454. P.107–117. Huettmann F., Artukhin Yu., Gilg O. & Humphries G. 2011. Predictions of 27 Arctic pelagic seabird distributions using public environmental variables, assessed with colony data: a first digital IPY and GBIF open access synthesis platform. Marine Biodiversity. March 2011, Vol. 41, Issue 1. P. 141-179. Hansen, M. B., Scheck-Wenderoth, M., Hübscher, C., Lykke-Andersen H., Dehghani, A., Hell, B., Gajewski, D., 2007 Basin evolution of the northern part of the Northeast German Basin - insights from a 3D structural model. Tectonophysics 437 (1-4), 1 – 16 Specific literature will be announced during the courses

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Module 5 Processes in the Coastal Zone and Environmental Management

Module title	**Module 5** **Processes in the Coastal Zone and Environmental Management**
Abbreviation	M5
Module goals / Learning outcomes	After completing this module, the students • are able to understand and to review international regulations and frameworks relevant to marine and coastal zone management and current cooperation trends and developments • understand the basics in environmental management concepts and approaches, systems and processes, current trends • understand principals of sustainable development and have obtained practical skills in methodology of industrial impact as-sessment for oil and gas extraction Arctic areas • are able to examine marine information systems as end-users, indicating objectives, components, variables; to formulate and to solve tasks using the marine information systems (MIS) • carry out independently: measurement, analysis, interpretation and data processing • understand and have obtained practical skills in basic geostatistics • have gained advanced knowledge of major coastal processes including natural and anthropogenic forcing of erosion and other sediments • develop monitoring strategies in coastal zones
Content	Module covers a range of topics on coastal zone environment and coastal zone management using case studies: • basics in international environmental regimes and laws • environmental management concepts and approaches, their development • coastal zone indigenous communities and conflicts between traditional and industrial use of resources. Assessment of the industrial impact on local population • basics of MIS development. Studying several web-based MIS, presenting them to others • basics of the decision support process, data collection, criteria development and assessment, evaluation of uncertainty and risk in the decision making process. Practical realization of several tasks, using GIS tools to support decision making process • physical processes in coastal zones and engineering, modeling and data exploration in coastal geosciences • applied geostatistics: basic principles and methodology • coastal zones eutrophication, monitoring and assessment
Educational concept	8 courses include lectures with seminars and practical exercises: 5.1 Statistical analysis of spatial data (Geostatistics); L,P; L, P [NN] CP 0.5 / 9 h 5.2 Eutrophication, monitoring, assessments, management; L, S [B. von Bodungen, M. Böttcher] CP 2 / 24 h 5.3 Marine Environmental Law; L, S [S. Schlacke, B. Huggins, N. Kharlampieva] CP 1.5 / 21 h 5.4 Engineering in the Coastal Zone and numerical modelling of Coastal Processes; L, S [P. Fröhle, A. Gruhn] CP 1.5 / 20 h

Module title	**Module 5** **Processes in the Coastal Zone and Environmental Management**	
	5.5 Modern approaches towards environment management: co-management; L, S [K. Klokov] CP 0.5 / 8 h 5.6 Indigenous population and industrial development in Arctic areas: impact assessment and sustainable development strategies; L, S [K. Klokov] CP 1.5 / 20 h 5.7 Integrated water management systems for the Arctic and sub-arctic regions; L, S, P [N. Bobylev] CP 0.5 / 10 h 5.8 Decision support tools and forecasting; L, P, S [N. Bobylev] CP 1 / 12 h	
Language	English	
Term, duration, frequency of offer	Term 2, summer semester Duration: one semester Frequency of offer: every second year in summer semester	
Workload	Campus study	120 h
	Self-Study	120 h
	Exam preparation	30 h
Examinations / Types of examinations	Type:	1 written module exam
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory
	Language:	English
	Duration / size:	Max. 90 min.
	Grade:	Average grade of the courses
Credit points (ECTS)	9.0	
Formal requirements for participation	None	
Recommended pre-requisites	Basic skills in ecology, environmental management and GIS	
Module type	Compulsory	
Module Supervisor	B. von Bodungen, K. Klokov	
Lecturers	N. Bobylev, B. von Bodungen, M. Böttcher, H. Burger, P. Fröhle, A. Gruhn, N. Kharlampieva, K. Klokov, S. Schlacke	
Literature	Alekseev, G. V., 1998: Arctic climate dynamics in the global environment. World Climatology Research Program, World Meteor-ological Org. Geneva (908), 11-14.	

Module title	Module 5 Processes in the Coastal Zone and Environmental Management
	Barbier, E.B. (ed.), 1993: Economics and ecology. New frontiers and sustainable development. Bass, S., 1993: Ecology and Economics in Small Islands: con-structing a framework for sustainable development. Chapman & Hall, London, 205 pp. CEM, 2002: Coastal Engineering Manual. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes) http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=PUBLICATIONS;8 Davis, J.C., 2002: Statistics and Data Analysis in Geology. Wiley, New York, 638 pp. Drugov, Ju. S., 2000: Ecological analytical chemistry. Moscow, 434 pp. Kirchner, A. (ed.), 2003: International Marine Environmental Law. Kluwer Law International, The Hague, 268 pp. Sherman, K., Skjoldal, H. R. (eds.), 2002: Large Marine Eco-systems of the North Atlantic, Elsevier, Amsterdam. J.C. Davis: Statistics and data analysis in geology. Third Ed. Wiley, 2002 Science and Integrated Coastal Management. Dahlem Konferenzen. 2001. B. v. Bodungen & K. Turner (eds). Dahlem University Press, 328pp (Dahlem Workshop Report 85) Sustainability or Collaps. An Integrated History and Future of People on Earth. 2007. R. Constanza, L. Graumlich & W. Steffen, MIT Press, 495 pp Review of the Literature on the Links between Biodiversity and Climate Change – Impacts, Adaptation, Mitigation. 2009. CBD (Convention on Biological Diversity) Technical Series 42, pp 124 EU – Marine Strategic Framework Directive (MSFD). 2008/56/EC – EUR-Lex 32008/0056 HELCOM 2007. Baltic Sea Action Plan. Balti Sea Environment Proceedings Schlesinger W. H., 2013, Biogeochemistry – an analysis of global change. Elsevier, Amsterdam, 688 pp. Schulz, H.D., Zabel, M., 2006, Marine Geochemistry, Springer, Heidelberg, 547 pp. Till Markus, Challenges and Foundations of Sustainable Ocean Governance (forthcoming) – the document will be provided as a pdf-file Ulrich Beyerlin/Thilo Marauhn, International Environmental Law, 2011 WBGU (German Advisory Council on Global Change), World in Transition: Governing the Marine Heritage – Flagship Report 2013. WBGU (German Advisory Council on Global Change), Climate Protection as a World Citizen Movement – Special Report 2014. (You will find the WBGU-documents as pdf-documents on the homepage of the WBGU: www.wbgu.de (English version).) Specific literature will be announced during the courses

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Module 6 Periglacial Environments

Module title	**Module 6 Periglacial Environments**	
Abbreviation	M6	
Module goals / Learning outcomes	After completing this module, the students • are able to understand and to review international regulations • have gained advanced knowledge of the structure of periglacial environmental systems and effects of basic cryogenic processes, types and dynamics of ground ices, glaciers and water bodies • carry out independently: measurement, analysis, interpretation and data processing • can evaluate anthropogenic impacts on periglacial ecosystems • are able to evaluate the impact of global climate change on periglacial environment	
Content	Introduction to periglacial environment as dominant in the polar regions: • basic cryogenic processes, cryogenic landforms, thermokarst formation and gas hydrate distribution • permafrost, its distribution and properties, active layer and cryosols • biochemical and microbiological processes in Arctic environment • water resources: river runoff and periglacial lake/swamp complexes, glaciers and ice caps • climate variability and its influence on periglacial environment, current trends in periglacial systems due to global warming • man-induced changes in periglacial ecosystems • natural disasters in polar regions	
Educational concept	4 courses include lectures with seminars, practical exercises and excursion: 6.1 Periglacial environment systems and climate change; L, S [K. Chistyakov, D. Ganushkin, G. Grosse] CP 3 / 36 h 6.2 Glaciers and ice caps; L, S, P [K. Chistyakov, D. Ganushkin] CP 1 / 20 h 6.3 Cryogenic processes, cryosols, geochemical cycles in polar regions; L, S, E [C. Knoblauch, S. Lesovaya, E.-M. Pfeiffer] CP 3 / 36 h 6.4 Periglacial water bodies, river runoff and basic types of antropogenic influence on water bodies of polar land [I. Fedorova, T. Potapova, V. Vuglinsky, S. Zhuravlev] CP 2 / 28 h	
Language	English	
Term, duration, frequency of offer	Term 2, summer semester Duration: one semester Frequency of offer: every second year in summer semester	
Workload	Campus study	120 h
	Self-Study	120 h
	Exam preparation	30 h

Module title	**Module 6 Periglacial Environments**	
Examinations / Types of examinations	Type:	1 written module exam
	Requirements for registration for examination:	Participation in lectures, excursions, practical training and seminars is obligatory
	Language:	English
	Duration / size:	Max. 90 min.
	Grade:	Average grade of the courses
Credit points (ECTS)	9.0	
Formal requirements for participation	None	
Recommended pre-requisites	Basics in biology, hydrology and chemistry	
Module type	Compulsory	
Module Supervisor	K. Chistyakov, G. Grosse, E.-M. Pfeiffer, V. Vuglinsky	
Lecturers	K. Chistyakov, I. Fedorova, D. Ganushkin, G. Grosse, C. Knoblauch, S. Lesovaya, G. Menzhulin, E.-M. Pfeiffer, T. Potapova, V. Vuglinsky, S. Zhuravlev	
Literature	French, H. M., 2010. The Periglacial Environment. Pearson Education, 762 pp. Hoefs, J., 2009. Stable Isotope Geochemistry, 4th Edition. Springer Berlin, 201 pp. Kimble, J.M. (ed.), 2004. Cryosols. Permafrost-Affected Soils. Springer Berlin. 726 pp. Lammers, R.B., Shiklomanov, A.I., Vorosmarty, C.J., Fekete, B.M., and Peterson, B.J., 2001. Assessment of contemporary arctic river runoff based on observational discharge records. Journal of Geophysical Research, 106 (3), 321-334. Magnuson, J., Robertson, D., Benson, B., Wynne, R., Livingstonk, D., Arai, T., Assel, R., Barry, R., Card, V., Kuusisto, E., Granin, N., Prowse, T., Steward, K., and Vuglinsky, V., 2000. Historical Trends in lake and river ice cover in the Northern Hemisphere. Science, 289 (1), 743-746. Yershov, E. D., 1998. General Geocryology. Cambridge University Press. Vuglinsky,V., 2017. Assessment of changes in ice regime characteristics of Russian lakes and rivers under current climate conditions, Natural Resources, 8, pp. 416-431. Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Semester 3 – Winter Semester

Semester in Germany at the Hamburg University or at the partner universities: Bremen University, Christian Albrecht University of Kiel*, Potsdam University

Symbol	**DS**	
Title	Semester abroad at one of the partner universities in Germany	
Learning outcomes	Graduates are able to understand and to evaluate the complex marine and terrestrial Arctic systems concerning vulnerability and impact of climate changes	
Contents	Semester abroad at one of the partner universities in the following M.Sc. programs: - University of Hamburg: Integrated Climate System Sciences (M.Sc. ICSS) / Climate change, permafrost and polar systems - University of Bremen: M.Sc. Marine Biology / Marine biology in Arctic regions; M.Sc. Marine Geosciences - Christian Albrecht University of Kiel: M.Sc. Marine Geosciences / Marine and polar geosciences - University of Potsdam: M.Sc. Geosciences/Geology / Geology with focus on periglacial environments Every partner M.Sc.* offers the following module components: Seminar, Study Project and Climate Sciences Additionals.	
Educational concept	- DS 1: Seminar 3 CP - DS 2: Study Project 15 CP - DS 3: Climate Sciences Additionals 12 CP L, S, P, E	
Language	English	
Formal requirements for participation	Successful completion of 60 CP of M.Sc. POMOR	
Recommended prerequisites	See specific requirements of the participating M.Sc. programs	
Grading framework (possibly including examinations)	Type:	Study Project, optional: 3-5 exams
	Language:	English
Credits	30.0	
Workload	Campus study:	150 hours
	Self-study:	480 hours
	Exam preparation:	270 hours
Module type	Compulsory	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Compulsory for M.Sc. POMOR	
Supervisor	Hamburg University: E.-M. Pfeiffer	

	Bremen University: H. Auel Christian Albrecht University of Kiel: R. Schneider Potsdam University: G. Grosse
Course lecturer(s)	See extracts from module handbooks of the partner universities attached
Literature	See specific announcements for the individual courses

*Kiel University offers lectures and seminars. Study project can be offered only if there is a special arrangement with the potential supervisor.
Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Hamburg University

Symbol	**DS / Hamburg University (UHH) - overview**	
Title	Semester abroad at the University of Hamburg	
Learning outcomes	The students solve research oriented problems and evaluate processes in the Arctic with focus on climate-related research questions. They communicate with colleagues from different disciplines and are able to generate, to interpret and to combine scientific results in the field of marine and polar sciences.	
Contents	Based on the modules of the M.Sc. ICSS students can choose different courses: DS 1 UHH: Seminar DS 2 UHH: Study Project DS 3 UHH: Additionals in Climate Science	
Educational concept	L, S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	Knowledge of mathematics and physics may be required. See module description and the specific announcements for the individual courses.	
Grading framework (possibly including examinations)	Type:	3-5 exams
	Language:	English
Credits	30.0	
Supervisor	E.-M. Pfeiffer	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E

Symbol	**DS 1 UHH**	
Title	Seminar	
Learning outcomes	The students have in-depth theoretical and practical expertise with different methods and can apply them for climate relevant questions in Arctic systems.	
Contents	Seminar, 3 CP	
Educational concept	L, S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	Knowledge of mathematics and physics may be required. See module description and the specific announcements for the individual courses	
Grading framework (possibly including examinations)	Type:	Presentation of the study project
	Language:	English
Credits	3.0	
Workload	Campus study:	
	Self-study:	
	Exam preparation:	
Module type	Elective	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	E.-M. Pfeiffer	
Course lecturer(s)	Lecturers are listed in the extract from the module handbook of the M.Sc. ICCS attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 2 UHH**	
Title	Study Project	
Learning outcomes	Students gained deeper and more specific understanding on different problems of arctic systems and are able to develop solutions.	
Contents	TBA	
Educational concept	L, S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	Knowledge of mathematics and physics may be required. See module description and the specific announcements for the individual courses	
Grading framework (possibly including examinations)	Type:	Written exams, written reports, tests
	Language:	English
Credits	15.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Elective	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	E.-M. Pfeiffer	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. ICCS attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 3 UHH**	
Title	Climate Sciences Additionals	
Learning outcomes	The students can answer research oriented questions and evaluate processes in the geosciences with focus on climate change processes in the Arctic. The students can discuss with scientist from different disciplines and are able to combine their own scientific results of the polar regions with other fields in the geo sciences.	
Contents	Recommended courses of the M.Sc. ICSS are: TBA	
Educational concept	L, S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	Knowledge of mathematics and physics may be required. See module description and the specific announcements for the individual courses	
Grading framework (possibly including examinations)	Type:	Written exams, written reports, tests
	Requirements for registration for examination:	
	Language:	English
Credits	12.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Elective	
Semester	Semester 3 of M.Sc. POMOR	
Frequencyofoffer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	E.-M. Pfeiffer	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. ICCS attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Bremen University

Symbol	**DS / Bremen University - overview**	
Title	Semester abroad at the Bremen University	
Learning outcomes	M.Sc. Program in Marine Biology utilizes both the expertise and the state-of-the-art research infrastructure for a progressive education of a new generation of marine scientists.	
Contents	Based on the modules of the M.Sc. Marine Biology students can choose the following courses: DS 1 UHB: Specialization: Student Research Project DS 2 UHB: Elective Courses DS 3 UHB: Research Grant Proposal	
Educational concept	L, S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	3-5 exams
	Language:	English
Credits	30.0	
Supervisor	NN	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 1 UHB**	
Title	Specialization: Student Research Project in Polar Marine Biology	
Learning outcomes	Students will learn how to carry out a scientific project, including state-of-the-art methodology, data analysis and report writing. The Student Research Project includes the same steps as the following master thesis project, albeit on a smaller scale. Students get into contact with modern methods and active research.	
Contents	POMOR students conduct a practical research project in the field of Polar Marine Biology integrated in a research team at the AWI or at Bremen University. Scientific content and methodologies will depend on the actual project topic	
Educational concept	S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written project report
	Language:	English
Credits	12.0	
Workload	360 h	
Module type	Compulsory	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	NN	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Marine Biology attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 2 UHB**	
Title	Additional courses	
Learning outcomes	Students have gained theoretical background in marine biology and biological oceanography. They understand modern scientific concepts and get familiar with the research topics and facilities of these partner institutions, which all are actively involved in teaching at the University of Bremen. Students can write scientific publications, give excellent oral and poster presentations at conferences and have obtained German language skills	
Contents	- Principles of Marine Biology and Biological Oceanography; L, S [V. Smetacek]; CP 5 - Marine Research in Bremen; P, E [AWI, ZMT, MPI] CP 1 - Scientific Communication; L, S [D. Abele, A. Cembella] CP 3 - German language; L, S [Goethe Institute] CP 3	
Educational concept	L, S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written exams, written reports, tests and oral presentations
	Language:	English
Credits	9.0	
Workload	270 h	
Module type	Elective for POMOR	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Coordinator	H. Auel	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Marine Biology attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 3 UHB**	
Title	Additionals: Research Grant Proposal	
Learning outcomes	Students can prepare a grant proposal for a research project	
Contents	After a brief introduction on how to write a grant proposal for a research project, students prepare the grant proposal on the topic of their master theses	
Educational concept	S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written grant proposal and oral defence of the grant proposal
	Language:	English
Credits	9.0	
Workload	270 h	
Module type	Elective for POMOR	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	NN	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Marine Biology attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Christian Albrechts University of Kiel

Symbol	**DS / Christian Albrecht University of Kiel (CAU) - overview**	
Title	Semester abroad at the Christian Albrecht University of Kiel	
Learning outcomes	Students have obtained the latest state of marine geosciences and technology, in particular in marine geology, past climates, biogeochemistry and paleoecology; they know fundamental terms of geological, biological, geochemical and physical processes in the ocean. The students can create and critically assess scientific results and plan, carry out and evaluate ship and laboratory projects on their own responsibility.	
Contents	Based on the modules of the M.Sc. Marine Geosciences students can choose different courses: DS 1 CAU: Specialization: Marine Geosciences DS 2 CAU: Elective Courses DS 3 CAU: Additionals in Marine Geosciences	
Educational concept	L, S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written exams
	Language:	English
Credits	30.0	
Supervisor	R. Schneider	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 1 CAU**	
Title	Specialization: Marine Geosciences	
Learning outcomes	The students have acquired knowledge on marine hydrothermal and volcanic systems and their associated ore deposits and have obtained competence in professional economic geology and deep sea mining techniques. They understand isotope fractionation in stable, radiogenic, radioactive, traditional and non-traditional isotope systems.	
Contents	Recommended courses of the M.Sc. Marine Geosciences are: - Marine Resources (MNF-mgeo-MR); L [S. Petersen] CP 3 - Evolution of Biosphere and Climate (MNF-mgeo-MP1); L [NN] CP 4 - Biogeochemistry (MNF-geow-MP4); L, P [K. Wallmann] CP 5 - Chemical Paleoceanography (MNF-mgeo-CP); L, S [M. Frank] CP 4 - Modelling in Marine Geosciences (MNF-mgeo-MMG); E [B. Schneider] CP 6	
Educational concept	L, S	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written exams
	Language:	English
Credits	9.0-12.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Compulsory	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	R. Schneider	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Marine Geosciences attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 2 CAU**	
Title	Elective Courses	
Learning outcomes	The students have obtained well-grounded knowledge of isotope geochemistry and geochronology. They can analyze sedimentary structures, and reconstruct sediment-dynamic processes applied to the coastal zone of Schleswig-Holstein. The students can carry out independent analytical data acquisition and validation.	
Contents	Recommended courses of the M.Sc. Marine Geosciences are: - Petrology/Geochemistry (MNF-geow-MP5); P, L, S [C. Devey] CP 3 - Introduction to Climate Sciences (MNF-mgeo-CLIM); L, E [B. Schneider] CP 5 - German Course I; S CP 6	
Educational concept	L, S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written exams
	Language:	English
Credits	9.0-12.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Compulsory	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	R. Schneider	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Marine Geosciences attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 3 CAU**	
Title	Additionals in Marine Geosciences	
Learning outcomes	The students understand complex biogeochemical fluxes in the ocean and marine environmental change in Earth´s History. They have obtained knowledge of state of the art chemical laboratory techniques applied to marine sediments. The can critically examine innovative topics of paleontological research.	
Contents	Recommended courses of the M.Sc. Marine Geosciences are: - Marine Geosystems (MNF-mgeo-MGS); L, S [A. Eisenhauer] CP 2 - Basin Analysis (MNF-geow-MP3); L [L. Rüpke] CP 5 - Coastal Geology (MNF-mgeo-MP2); L, S [K. Schwarzer] CP 4	
Educational concept	L, S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written exams
	Language:	English
Credits	9.0-12.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Compulsory	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	R. Schneider	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Marine Geosciences attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Potsdam University

Symbol	**DS / University Potsdam - overview**	
Title	Semester abroad at the Potsdam University	
Learning outcomes	The students understand environmental processes and driving forces of the climate system through earth history. They have obtained advanced knowledge in geosciences with focus on permafrost and geology.	
Contents	Based on the modules of the M.Sc. Geosciences/Geology students can choose different courses: DS 1 UP: Specialization: Permafrost and Palaeoclimate DS 2 UP: Elective courses: Topics in Geosciences DS 3 UP: Additionals: Internship at the AWI	
Educational concept	L, S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	3-5 exams
	Language:	English
Credits	30.0	
Supervisor	G. Grosse	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 1 UP**	
Title	Specialization: Permafrost and Paleoclimate	
Learning outcomes	The students understand the principles of formation and the characteristics of permafrost and the formation and degradation of periglacial landscapes. They have studied environmental processes and driving forces of the climate system through earth history.	
Contents	Recommended courses of the M.Sc. Geosciences/Geology are: - Permafrost landscapes (MGEW15); L, S, P [NN] CP 6 - Paleoclimate dynamics (MGEW13); L, P [NN] CP 6	
Educational concept	L, S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written exam
	Language:	English
Credits	6.0-12.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Elective	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	G. Grosse	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Geosciences/Geology attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 2 UP**	
Title	Elective courses: Topics in Geosciences	
Learning outcomes	Students have acquired in-depth knowledge of the methods of basin analysis and petroleum systems. Students understand the impact of the events in Earth history on the climate change	
Contents	Recommended courses of the M.Sc. Geosciences/Geology are: - Sedimentary Basins (MGEP05); L, S, P [NN] CP 6 - Petroleum Geology (MGEW03); L, S, P [NN] CP 6 - Events in Earth History (MGEW04); L, S, P [NN] CP 6	
Educational concept	L,S, P	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written and oral exams, seminar talks
	Language:	English
Credits	6.0-12.0	
Workload	Campus study:	50 hours
	Self-study:	160 hours
	Exam preparation:	90 hours
Module type	Elective	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	G. Grosse	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Geosciences/Geology attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Symbol	**DS 3 UP**	
Title	Additionals: Internship at the AWI	
Learning outcomes	The students have obtained practical knowledge and skills in selected areas of geosciences	
Contents	Internship at the AWI	
Educational concept	S, P, E	
Language	English	
Formal requirements for participation	None	
Recommended prerequisites	None	
Grading framework (possibly including examinations)	Type:	Written report
	Language:	English
Credits	12.0	
Workload	360 h	
Module type	Elective	
Semester	Semester 3 of M.Sc. POMOR	
Frequency of offer	Every second year in winter semester	
Duration	1 semester	
Usability	Elective for M.Sc. POMOR	
Supervisor	G. Grosse	
Course lecturer(s)	See an extract from the module handbook of the M.Sc. Geosciences/Geology attached	
Literature	Specific literature will be announced during the courses	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion E.

Semester 4 – Summer Semester

M.Sc. Thesis

Symbol	**MT**	
Title	M.Sc. Thesis “Polar and Marine Sciences”	
Learning outcomes	The graduates demonstrate the ability to elaborate and to present an innovative M.Sc. thesis in a specific field of applied polar and marine sciences	
Contents	The student will carry out an in-depth study of a chosen topic in applied polar and marine sciences under the co-supervision of scientists and lecturers within the POMOR network in Russia and Germany. The study will involve a critical review of the topic and/or the original research, will show the significance of the chosen topic for applied polar and marine sciences and lead to an extended master thesis. The master thesis is embedded in an on-going research project.	
Educational concept	Practical work, writing the master thesis and oral presentation of the master thesis	
Language	English	
Formal requirements for participation	Completion of 60 CP of the M.Sc. POMOR	
Recommended Prerequisites	None	
Grading framework (possibly including examinations)	Type:	M.Sc. thesis and oral presentation
	Requirements for registration for examination:	None
	Language:	English
	Duration / size:	
	Possibly weighted by the credits for the module grade:	Thesis 80% and oral presentation including discussion 20%
Credits	30.0	
Workload	Campus study:	
	Self-study:	22 weeks
	Exam preparation:	
Course type	Compulsory	
Semester	Semester 4 of M.Sc. POMOR	
Frequency of offer	Every second year in summer semester	
Duration	1 Semester	
Usability	Compulsory	
Supervisor	G. Cherkashov, E.-M. Pfeiffer, J. Thiede	
Lecturer(s)	All advisors	

Abbreviations: Lecture L. Practical training P. Seminar S. Excursion.