



Miejszynaarodowa Środowiskowa Szkoła Doktorska
przy **Centrum Studiów Polarnych**
w Uniwersytecie Śląskim w Katowicach

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No. of PhD project: IEDS/2023/IO/B

Title of PhD project: Ocean mixed layer dynamics under freezing and highly turbulent conditions – laboratory measurement and numerical modelling

The leading unit: Institute of Oceanology, Polish Academy of Sciences

Requirements:

1. MSc in physics, mathematics, physical oceanography or related field.
2. MSc thesis related to fluid dynamics, numerical modelling of ocean currents, waves and/or sea ice, or closely related subjects, will be an advantage. Otherwise, documented practical experience related to these subjects.
3. Additional advantages: knowledge of polar oceanography and sea ice physics and dynamics; experience in conducting laboratory work, e.g. in wave tanks; (co)authorship of scientific papers and conference presentations.
4. High motivation for scientific work.
5. Practical skills: basics of Linux; programming; data processing and visualization; typesetting of scientific texts; Matlab.
6. Good skills in speaking and writing in English.

Tasks description:

1. Participating in the laboratory work at SOARS (see project description below) and in data processing
2. Developing a model of frazil thermodynamics and dynamics in the turbulent ocean mixed layer: working on the code of the model, model testing, calibration and validation, application of the model to idealized and realistic case studies, etc.
3. Cooperating with the PI on the remaining tasks in the project, especially those related to hydrodynamic modelling.
4. Preparing of publications and conference presentations, presenting the results at international conferences.

Summary of a doctoral project:

The doctoral project is part of the NCN-funded research project „Sea ice, waves and turbulence – from laboratory scale to improved large-scale modeling”. The subject of the project are interactions between sea ice, wind-generated ocean waves and turbulence in the ocean mixed layer (OML). The project concentrates on two groups of processes: (i) wave energy dissipation due to turbulence in the boundary layer under ice; (ii) interactions between Langmuir circulation, waves and frazil ice dynamics and production in coastal polynyas. The core of the project are laboratory experiments at the Scripps Ocean–Atmosphere Research Simulator ([SOARS](#)), a new, unique facility at the Scripps Institution of Oceanography, designed specifically to study ocean–



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atmosphere interactions under very dynamic, turbulent conditions, including polar regions. Main project objectives:

1. To create an observational database related to the two groups of processes listed above, based on a series of laboratory experiments at SOARS.
2. To use the collected laboratory data to validate and, if necessary, improve the new source term for spectral wave models describing dissipation due to under-ice turbulence, developed recently by [Herman, \(2021\)](#) and based on Weber (1991). In particular, to test the suitability of the eddy-viscosity model, relating the turbulent shear stress to vertical gradients of velocity within the boundary layer, as an underlying model for that source term.
3. To use the improved, validated source terms in realistic WaveWatchIII and SWAN simulations in order to assess the contribution of turbulent dissipation to the total wave energy attenuation in sea ice in various wave forcing and ice conditions in the Arctic and Antarctic.
4. To develop further the OML+frazil model by [Herman et al. \(2020\)](#) in order to make it suitable for realistic simulations in coastal polynyas. In particular, to implement in the model frazil thermodynamics. To use the model, together with laboratory data and high-resolution satellite imagery, to improve our understanding of interactions between polynya dynamics, wave growth and frazil processes.
5. To formulate a (set of) wave growth and dissipation source term(s) for spectral wave models suitable for turbulent conditions with frazil/grease ice, and to describe source terms balance in fetch-limited, strong-wind situations characteristic of coastal polynyas.

The work of the PhD student will concentrate on tasks from groups 1 and 4 above.

Other information:

The work will be carried out under supervision of: dr hab. Agnieszka Herman, prof. IOPAN (agaherman@iopan.pl), Institute of Oceanology PAN

Secretary of the IEDS Recruitment Committee: +48 32 3689 380, e-mail: polarknow@us.edu.pl

Information on the IEDS admissions: https://www.mssd.us.edu.pl/en/admission_2023_2024-proj/