

Water, Heat and Salt Fluxes Between the North Sea and the Baltic Sea

Summary

The quantification of volume, heat, and salt fluxes between the ocean (North Sea) and a marginal sea (Baltic Sea) remains one of the most challenging and critical problems in regional oceanography. The dynamics of this exchange govern the salinity, stratification, and deepwater ventilation of the Baltic Sea, with far-reaching implications for its biogeochemistry and ecosystem health. This PhD project will focus on quantifying these fluxes through the narrow and topographically complex Danish Straits (Øresund, Great Belt, Little Belt), combining high-resolution observations and state-of-the-art ocean modeling. The project contributes to ongoing national and international research collaborations and provides opportunities for advanced training in ocean physics, climate impact studies, and numerical modeling.

Research field:	Earth sciences
Supervisor:	Prof. Dr. Urmaz Raudsepp
Availability:	This position is available.
Offered by:	School of Science Department of Marine Systems
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

This PhD research will investigate the physical exchange processes of water, heat, and salt between the North Sea and the Baltic Sea via the Danish Straits. Using a combination of long-term observational datasets (e.g., moorings, ADCPs, satellite data) and high-resolution 3D hydrodynamic modeling tools (such as GETM, HBM, or NEMO-Baltic), the student will:

- Quantify volume fluxes through the straits under varying meteorological and oceanographic conditions.
- Analyze episodic events such as Major Baltic Inflows and their contributions to salinity and thermal budgets.
- Assess the role of baroclinic and barotropic forces, wind forcing, and large-scale atmospheric patterns (e.g., NAO) on the flux variability.
- Investigate trends under climate change scenarios, including changes in sea level, precipitation, and stratification.

The project will include the development or refinement of coupled physical-biogeochemical model components as needed and will contribute to regional climate adaptation strategies.

Responsibilities and (foreseen) tasks

- Perform literature review and synthesis on North Sea–Baltic Sea exchange dynamics.
- Process and analyze observational datasets from multiple sources (moorings, satellites, etc.).
- Set up and calibrate 3D hydrodynamic models for the study region.
- Conduct sensitivity and scenario analyses of exchange processes under various forcing conditions.
- Present findings at international conferences and publish results in peer-reviewed journals.
- Collaborate with other project partners within international research networks.

Applicants should fulfil the following requirements

- MSc degree (or equivalent) in physical oceanography, marine science, applied physics, or environmental engineering.
- Strong background in fluid dynamics, thermodynamics, and numerical modeling.
- Good programming skills (e.g., MATLAB, Python, Fortran).
- Proficiency in written and spoken English.
- Motivation and ability to work both independently and as part of a multidisciplinary team.

The following experience is beneficial

- Experience with ocean model setups (GETM, HBM, NEMO, or similar).
- Familiarity with data assimilation techniques.
- Prior experience in working with large observational datasets (e.g., Copernicus, CMEMS, FerryBox).
- Background in climate variability and air-sea interaction processes.

We offer

- A 4 year fully funded PhD position in a dynamic research environment.
- Access to national and international datasets and computing resources.
- Supervision from leading experts in physical oceanography and coastal dynamics.
- Support for professional development including conference travel and courses.
- A competitive salary and social benefits according to university regulations.

About the department

The PhD candidate will be hosted by the [Department of Marine Systems at TalTech or relevant university], which has long-standing expertise in the physical oceanography of the Baltic Sea and North Sea regions. The department participates actively in international research consortia such as Baltic Earth, EuroSea, and CMEMS. The candidate will have access to high-performance computing facilities, state-of-the-art instrumentation, and opportunities for collaboration with partners across Europe.



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